

**BITUMINOUS COAL LOSSES AND MINING METHODS
IN PENNSYLVANIA**

JAMES D. SISLER



Bituminous Coal Losses
and
Mining Methods in Pennsylvania
including Thickness, Character,
and Reserves of Coal

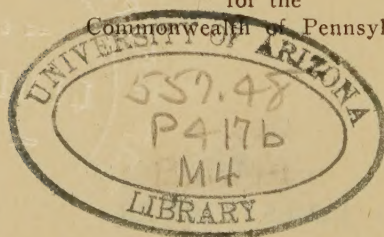
By
JAMES D. SISLER

[Published by cooperation with the United States Coal Fact Finding Commission and United States Bureau of Mines.]

Department of Forests and Waters
R. Y. Stuart, Secretary

Topographic and Geologic Survey
G. H. Ashley, State Geologist

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Secretary, Department of Forests and Waters
for the
Commonwealth of Pennsylvania



LETTER OF TRANSMITTAL.

R. Y. Stuart, Secretary,

Department of Forests and Waters.

Sir:—

Herewith is a text, with maps and illustrations, concerning a study of bituminous coal losses and mining methods in Pennsylvania, by J. D. Sisler. This study was made in cooperation with the United States Coal Fact Finding Commission, and is offered for publication as a product of the Topographic and Geologic Survey.

Respectfully,

Geo. H. Ashley

January 1924.

State Geologist.

51665

This publication is dedicated to the memory of

CARL A. ALLEN

Chief of the Salt Lake City, Utah, station of the U. S. Bureau of Mines. His over-zealous efforts in studying coal waste in Ohio and West Virginia mines for the United States Coal Fact Finding Commission directly resulted in his death April 1923.

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BITUMINOUS COAL LOSSES AND MINING METHODS IN PENNSYLVANIA.

By James D. Sisler.

PREFACE.

The United States Coal Fact Finding Commission was appointed by President Warren G. Harding to investigate all phases of the coal mining industry in the United States and report to Congress.

Among many studies was that of mining methods and coal losses. This engineering problem, as well as others, was completed under cooperative agreement with the United States Bureau of Mines. That Bureau, realizing the magnitude of the problem, and great value of its solution, appealed to various State institutions for help and information. With the sanction of Governor William C. Sproul, the Pennsylvania Geological Survey was requested to furnish a man to undertake this study in the bituminous coal fields of Pennsylvania, and later Governor Gifford Pinchot approved the continuation of the work.

Conferences between the State Geologist and members of the United States Bureau of Mines resulted in plans for the collection of material, and the procedure of study in the field and office. As a result of these conferences James D. Sisler, Coal Geologist of the Pennsylvania Geological Survey, was assigned to studies of coal losses and mining methods in the bituminous coal fields of Pennsylvania. Work was started December 1, 1922, and was completed June 15, 1923. During this period Mr. Sisler devoted about 70 per cent of his time to field studies. The rest of the time was spent in supervising office studies and preparing district reports.

Mr. C. A. Allen, engineer for the United States Bureau of Mines, pursued the same study in other bituminous coal-producing States, and closely cooperated with Mr. Sisler. After the untimely death of Mr. Allen, Mr. Sisler was asked to complete his work in Ohio and West Virginia. Reports on these States will be published by the United States Bureau of Mines.

The methods employed are described in detail in the body of the text. Personal visits to State mine inspectors, mining engineers, and operators proved invaluable. In conjunction with these interviews intensive studies were made of representative mines in each district. Mines in different districts and within the same district vary much

in percentage of recovery. Guided by numerous conferences with men well versed in the problems of each district and in conjunction with his own knowledge of the field, Mr. Sisler was able to select mines which were fairly representative. The figures representing percentage of coal loss for each district are considered very accurate, and the descriptions of mining methods are typical of each district.

ACKNOWLEDGMENTS.

When the Coal Fact Finding Commission went out of existence its manuscript reports were left to the United States Bureau of Mines for printing. As one of the reports concerned Pennsylvania and had been written by a member of this Survey, I asked and received permission from the Director of the Bureau of Mines to publish it. This courteous cooperation on the part of the Federal bureau is gratefully acknowledged.

Mr. Sisler desires that I extend his thanks and appreciation to all who aided in this work. He wishes to extend his especial thanks to Mr. George S. Rice and Mr. J. W. Paul of the United States Bureau of Mines, under whose direction this report was completed.

Mr. R. W. Stone, Assistant State Geologist of Pennsylvania, was kind and untiring in offering most valuable suggestions concerning the form of presentation of the following reports. The Pennsylvania Department of Mines was exceedingly helpful by offering all of its information. Its mine inspectors were particularly helpful. Without their assistance this report would lack much of its accuracy and fullness. Messrs. John Ira Thomas, Johnstown, F. W. Cunningham, Somerset, and Richard Maize, Uniontown, all mine inspectors, were especially cordial in their cooperation.

The chief engineers and consulting engineers of various coal companies, and many operators, have been personally thanked for their kind cooperation with the United States Coal Commission.

Mr. Sisler wishes to express his appreciation for the great interest and help given to the routine phases of this study by Mrs. Anna C. Bock, Mr. Frank Shaffner, Miss Marie M. Johnstone, Miss Emily P. Flynn, and Miss Elizabeth B. Garner, of the Pennsylvania Geological Survey.

The results of these studies speak for themselves. I can only add my own word of appreciation for the thorough way in which Mr. Sisler has handled this subject and his untiring energy in getting at the facts.

GEO. H. ASHLEY,
State Geologist.

CHAPTER I

TOPOGRAPHY AND GEOLOGY OF THE PENNSYLVANIA BITUMINOUS COAL FIELD.

The main bituminous coal field of Pennsylvania lies west of the mountain area which extends in a northeast-southwest direction through the central part of the State. The coal field lies in a dissected penepplain, still in the youthful stage of erosion. V-shaped valleys are numerous and the tributaries of the larger streams have steep gradients. The main streams flow in rather narrow valleys with comparatively small flood plains.

The rocks are folded into many anticlines and synclines extending in a general northeast-southwest direction across the western part of Pennsylvania. The intensity of this folding increases eastward toward the mountain region. West of Chestnut Ridge, which lies in Fayette, Westmoreland, and Indiana counties, the folding is minor and the coal beds have low dips. East of Chestnut Ridge, where folding is stronger, the basins are wider and the coal beds rise steeply on the flanks of the anticlines.

The coal beds of Pennsylvania are of Carboniferous age. They are confined to two systems, the Permian and Pennsylvanian. The Pennsylvanian system is divided into an upper or Pittsburgh series and a lower or Pottsville series. The Permian system is divided into an upper and lower series. The lower or Pottsville series of the Pennsylvanian is represented in the bituminous coal fields of Pennsylvania by the Upper and Middle Pottsville groups. The upper or Pittsburgh series is represented by the Monongahela, Conemaugh, and Allegheny groups. The Permian system includes the Greene and Washington groups.

The bituminous coal beds are associated with shale, sandstone, clay, and limestone. Each group has different proportions of these rocks and the proportions vary within the same group at different localities.

The Pottsville series is largely sandstone which is conglomeritic in extensive areas. It is practically barren of commercial coal beds, although a very unusual occurrence of the thick coal known as the "Sharon block" in Mercer County, was very important for many years. This bed is now exhausted after producing many tons of excellent high-grade, high-volatile coal.

On the northern edge of the bituminous coal field the Pottsville series contains two or three coals known as the Alton group. These coals are probably the northern extension of the Mercer coals in Mercer County. They are mined almost entirely for local use.

The Allegheny group, lying above the Pottsville series, contains the valuable Kittanning and Freeport coals, has the longest line of outcrop, and underlies a greater territory than any other coal-bearing group in Pennsylvania. Practically 50 per cent. of the bituminous coal production comes from beds in the Allegheny group. The main outcrop is in Westmoreland, Somerset, Cambria, Clearfield, Jefferson, Indiana, Clarion, Armstrong, Lawrence, and Beaver counties. The group ranges from 250 to 350 feet thick, averaging approximately 300 feet.

The mineable coals are, in ascending order, Brookville, Clarion, Lower, Middle, and Upper Kittanning, and Lower and Upper Freeport.

The Brookville is usually dirty and ranges from a few inches to 8 feet thick. It has local importance in Cambria, Somerset, Armstrong, Butler, Clarion, Jefferson, Indiana, Elk, Clearfield, and Centre counties.

The Clarion coal is generally a thin bed, high in sulphur and ash, but locally is double and workable. Its best development is near its type locality at Clarion, Clarion County. It is also locally mineable in Butler and Armstrong counties.

The Lower Kittanning is probably the most persistent coal bed in the Allegheny group. It is seldom under 15 inches thick and rarely exceeds 7 feet. The variation is not in the main bench but in the presence or absence of lower benches. In areas where it is being mined at present it averages approximately 3 feet 6 inches. The bed usually is not clean, carrying partings and binders varying in thickness and character in different mining localities. The Lower Kittanning is important in eastern Fayette, Somerset, Indiana, Cambria, Clearfield, Jefferson, Armstrong, and Butler counties. It is deep under cover in the southwestern counties of Pennsylvania.

The Middle Kittanning coal is not persistent in Pennsylvania. It ranges from a few inches to 4 feet thick and is being mined at a number of places in Clearfield County, where it is regular in thickness. Where mined in Beaver County its correlation is uncertain, and it is known locally as the Darlington coal.

The Upper Kittanning is generally unimportant in most of the bituminous coal districts. It ranges from a few inches to 7 feet thick. The greatest thickness and best quality is in southern Cambria and northern Somerset counties where the bed is now being mined extensively. The Upper Kittanning is also locally important in Beaver County where it is a true cannel coal. It is being mined

locally in Armstrong, Jefferson, Clarion, and Clearfield counties. The Upper Kittanning is deep under cover in the southwestern counties of Pennsylvania and little is known of its thickness or value. It is probably workable in some areas.

The Lower Freeport is variable in thickness, ranging from a few inches to 16 feet. The bed is locally known as the Moshannon in Clearfield County and has produced large quantities of excellent smokeless steam coal. The Lower Freeport is the main bed of the Punxsutawney-Reynoldsville-DuBois areas, where it is from 4 to 11 feet thick. The bed is also being mined in Cambria County on the Conemaugh and in the vicinity of Barnesboro. It is extremely variable in thickness in other parts of the bituminous field and is mined locally where its thickness permits commercial development. The bed is much split in most localities. Drill hole records in southwestern Pennsylvania indicate that it is rarely of mineable thickness there.

The Upper Freeport is one of the most persistent and valuable beds in the Allegheny group. Its physical character is extremely variable. The Upper Freeport ranges from a few inches to 9 feet thick. In general it averages about 4 feet thick where mined. It usually contains two or more shale or bone partings and is rarely entirely clean. The chief production from this bed is in Cambria, Somerset, Clearfield, Jefferson, Armstrong, Indiana, and Allegheny counties. It is a thick bed at numerous localities in southwestern Pennsylvania but its development has been hindered by the presence of the valuable and more easily accessible Pittsburgh bed.

The Conemaugh group, ranging from 500 to 900 feet thick, is composed of shale, sandstone, limestone, and coal beds. It is distinguished from the over- and underlying formations by the presence of thick beds of red shale. The thickness of the group is greatest in Somerset County, and decreases westward until it is less than 500 feet in eastern Ohio.

This group contains some twenty coal beds, most of which average less than 12 inches thick. The Bakerstown, Harlem, and Wellersburg coals are locally mineable but their present use is restricted entirely to local domestic fuel. These beds range from a few inches to 4 feet thick, averaging less than 3 feet where mined.

The Monongahela group includes the strata between the top of the Waynesburg coal and the base of the Pittsburgh. It ranges from 200 to 375 feet thick. It is thickest on Monongahela River and thinnest on the Ohio-Pennsylvania State line.

The outcrop of this group is confined to Washington, Beaver, Allegheny, Indiana, Westmoreland, Fayette, and Somerset counties. The group is under cover in the southern part of Washington County and in practically all of Greene County except along Monongahela River.

The Pittsburgh coal, marking the base of the Monongahela group, is the best known and most valuable coal in southwestern Pennsylvania. It is quite persistent, averaging about 7 feet thick and ranging from 4 to 16 feet. Its uses are varied. It is a standard coking coal in the Connellsville basin of Westmoreland and Fayette counties; a high-grade illuminating gas coal in the Irwin basin of Westmoreland County; in Greene, southern Washington and western Fayette counties, an excellent by-product coking coal, and in western Washington and Allegheny counties it is a high-grade steam coal.

The Pittsburgh bed is characteristically divided into a roof and main division. The main division is usually split into four benches by thin bone or shale partings. The roof division is rarely of mineable quality because of numerous bone, clay, and shale partings.

The Redstone coal, commonly from 30 to 90 feet above the Pittsburgh coal, ranges from a few inches to 6 feet 6 inches thick. The variation in thickness is both large and abrupt, making mining unprofitable in most localities. This coal is being mined locally in Greene, Washington, Fayette, and Westmoreland counties but its chief importance is in Somerset County where it lies 17 to 28 feet above the Pittsburgh. Here it averages about 4 feet thick and yields a large quantity of coal each year.

The Sewickley coal, lying below the Waynesburg, ranges, from a few inches to 6 feet thick. It is most important in the vicinity of Mapleton in southeastern Greene County, but is also mined locally in Fayette, Washington, Westmoreland, and Somerset counties.

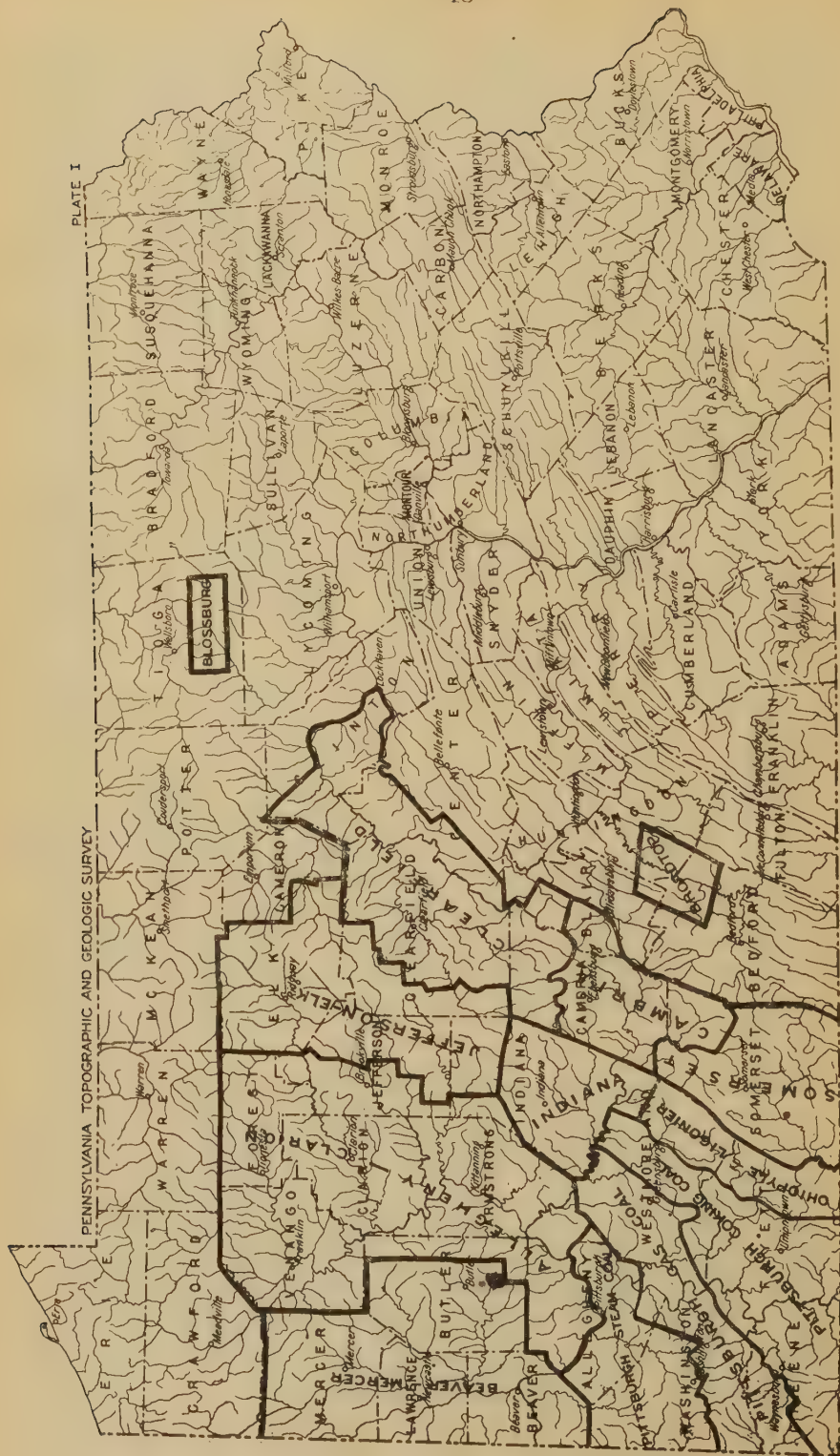
The Waynesburg coal, at the top of this formation, is important in some localities, particularly when demand is excessive. It ranges from 2 to 10 feet thick and is much parted by clay, bone, and shale. At many localities fully half the bed is impurities.

The Permian coals outcrop only in Greene and Washington counties. They are usually thin and dirty and have practically no commercial importance at present. Farmers are mining them locally for house fuel.

METHOD OF STUDYING COAL LOSSES.

At the beginning of the coal loss study the bituminous coal field of Pennsylvania was divided arbitrarily into thirteen districts. The divisions were based upon trade and shipping relations, physical and chemical character of the coals, and geographic and natural boundaries, and determined by consulting various engineers and geologists well versed in the problems of the coal industry of Pennsylvania.

The following plate shows the bituminous coal mining districts in Pennsylvania.



BITUMINOUS COAL DISTRICTS IN PENNSYLVANIA

The investigation was divided into three parts: first, all literature on coal waste and mining methods was reviewed; second, detailed information was collected by field work and by correspondence; third, the information was compiled in the office by the writer, assisted by Mr. Frank Shaffner of the Pennsylvania Geological Survey.

Field investigations were made in each district. A number of representative mines were chosen for inspection. The best and worst mines were selected for contrast and to prevent a prejudiced conclusion. The choice of mines was based upon the writer's knowledge of the field, substantiated by conferences with mine inspectors and mining engineers familiar with the district. Underground studies were made in company with a representative of the company who best understood the conditions in the mine. Detailed measurements were made of rooms, pillars, stumps, and entries and the thickness of the coal at many points in the mine. The method of mining was studied and every phase that had a direct bearing on the problem was investigated. After the writer had drawn preliminary conclusions concerning the coal losses in the mine, he conferred with operators, engineers, and State mine inspectors to compare results.

The actual check upon the primary estimate of coal losses was made in the office by comparing the tonnage mined out with the tonnage remaining in the ground. The coal in every mine was given an average thickness based upon a number of measurements taken in each mine during this study, and sections measured by the Topographic and Geologic Survey in its field studies. The production tonnages used were those reported to the Pennsylvania Department of Mines by the operators.

The areas of coal mined out and coal remaining were determined by a planimeter on mine maps obtained during field work and taken from the files of the Geologic Survey.

Numerous large companies have kept an accurate estimate of the recovery percentage in their mines. These figures were used in drawing final conclusions.

Blanks containing a series of questions which fully covered the problem of percentage of recovery were sent to many engineers in each district and to the State mine inspectors. The replies on these blanks offered the writer an excellent check upon his own observations.

During the work the writer personally inspected 150 mines and studied 400 maps.

The percentages of losses given in the tables are in terms of total merchantable coal. Merchantable coal is defined as coal that can be commercially marketed at a reasonable profit when prices are normal. A normal price is one which exists over an extended period and is not influenced by unusual economic conditions.

The minimum mineable thickness of a bed, based upon the classification of public lands by the United States Geological Survey, is fixed at 14 inches for coals having more than 12,000 B. t. u.; for coals having less than 12,000 B. t. u. the minimum mineable thickness increases at the rate of .1 inch for each decrease of 100 B. t. u. down to 11,000.

The vertical sections in figures and in text discussions are practically all from producing mines. The geological discussion is not complete, its purpose being to give the reader only a general idea as to the character of each coal bed in each district.

DEFINITIONS.

For the information of the readers of this publication the following mining terms are defined according to their use in Pennsylvania mining industry.

Air-slack: To disintegrate and spall off in contact with air and moisture.

Brattice: A partition to confine air and direct it into working places; a water or gas hazard barrier.

Butt heading: A drift driven at right angles to the butt cleat.

Crop, or crop coal: Abbreviation of outcrop. Applied to leached, inferior coal near the surface.

Creep: A squeeze or crush forcing pillars down, involving a lateral movement.

Curtain: A permanent thin pillar of coal left to assist mining and ventilation.

Draw slate: Any soft formation above the coal bed which falls with the coal or soon after the coal is mined.

Free-breaking: Applied to roof breaking in long regular planes parallel to the top of the coal.

Gob: Any waste coal and other minerals in coal mining; to pile coal and other material as waste in mining.

Gob line: The line of gob material used to control the movement in breaking the roof.

Gouge: To widen a room or entry beyond its intended width by pick or machine work.

Ground hog: The method of mining resembling the burrowing of a ground hog; emphasizing lack of plan and foresight.

Head coal: Top part of a coal bed left in place permanently or temporarily.

Heave: The rising of the floor of a mine caused by its response to weight on the pillars.

Knife blades: Layers or lenses of mineral matter no thicker than a knife blade.

Muck: Waste material, including sandstone, shale, etc., to be handled when mining coal.

Mushroom mine: A mine developed quickly and shortlived, owing its existence to unusual demand.

Pack wall: A wall or pillar built of gob or refuse to support the roof.

Pillar pulling, robbing, or drawing: The removal of pillars by pick or machine.

Pinch: The thinning of coal beds.

Roll: A local irregularity on either the roof or bottom; may cause thickening or thinning of the coal bed.

Room break-throughs: Narrow passage cut through a pillar to allow ventilating current to pass from one room to another; cross-cut.

Room neck: A narrow entrance to a room on the entry end.

Rider: A thin bed of coal closely overlying a thicker one.

Scrap: To remove coal by pick under machine cuts.

Shell: A hard band or layer of sandstone, bone, or shale in the coal bed; a small part of a coal pillar left to protect machine runners.

Sight: A bearing or angle taken with a compass or transit when making a survey.

Slab: A skip or slice taken off the rib of an entry or room.

Solid shooting: Blasting coal without first undermining, shearing, or cutting.

Squeeze: The settling of an unbroken roof over a coal bed; also called crush, pinch, or nip; also the upheaval of a mine floor due to unequal pressure on clayey strata.

Stepping-up: To raise the cutter bar in machine cutting up over rolls and inequalities on the bottom.

Stump: A small pillar left between the gangway or airway and the breast to protect these passages.

Sulphur: Iron sulphide in coal beds.

Sulphur binder: A lens or layer of iron sulphide difficult to separate from the coal.

Swamp: A local depression in a coal bed in which water accumulates.

CHAPTER II

CAUSES OF COAL LOSSES.

Coal losses are of two kinds—avoidable and unavoidable. The unavoidable losses include those in reservations under buildings, streams, railroads, and restricted properties, and around oil and gas wells. Under certain conditions other losses are unavoidable. These conditions are mostly natural and are influenced by economic conditions.

The determination of percentages of avoidable and unavoidable losses was based upon actual measurements of coal won and lost, upon the opinions gathered in conferences with the leading men in the bituminous coal industry of Pennsylvania, and upon the primary principles of coal economics. Avoidable and unavoidable losses have been separated in the coal loss tables under each district and in the summary table.

The causes of coal losses in Pennsylvania are numerous. The outstanding loss is in pillars. Another great loss is by leaving coal on the roof and bottom. The waste of inferior coal in beds having a main bench of excellent quality is purely an economic condition and in many mines cannot be prevented at present prices.

The following is an enumeration of the principal causes of coal losses in Pennsylvania:

(1) In districts where the initial cost of coal is cheap pillars are not pulled.

(2) Rooms are driven too wide and pillars are too narrow to support the heavy overburden and squeezes are induced.

(3) Too many rooms are turned off the headings in order to increase production temporarily. Mining stops in these rooms before they are worked out, the coal is squeezed, the roof caves, and the rooms are abandoned.

(4) Coal which is slightly thinner than the average thickness of the bed is left because cost of production is high.

(5) Many mines lack competent engineering supervision. The rooms and headings are not run on sights, and future development is not planned.

(6) Irregular and unsystematic break lines cause losses of extensive areas of coal.

- (7) Idle days, fluctuations of market, and strikes cause delays in mining and the loss of coal.
- (8) Retreat mining is delayed in an effort to produce coal at a minimum cost from virgin areas.
- (9) Machine men leave from 2 inches to 2 feet of coal on the top or bottom, according to the type of machine used, and the physical character of the roof and floor. This coal should be scrapped but in many mines it is left in place.
- (10) Much coal only slightly inferior to the average quality of the bed, is abandoned. This coal could be shipped separately.
- (11) Coal is left in place, particularly in the Connellsville basin, because the ash, sulphur, and phosphorus contents are too high for coking. This coal could be loaded and used for steam purposes.
- (12) The small operator buys a few acres of coal, ground-hogs it, mining only the thickest part of the bed and leaving the thin coal and large pillars. In this way thousands of acres of coal in Pennsylvania have been ruined.
- (13) Large quantities of coal are lost in mines operating on a small margin of profit when operators see that they are driving into a fault and do not want to run the risk of losing money by driving through it in the hope of reaching thicker coal beyond.
- (14) Where a fault cuts out the coal there is generally a gradual decrease in thickness. This thinner coal is abandoned.
- (15) Entirely too much coal is lost in handling and preparation, principally because of inferior methods of cleaning the coal.
- (16) Coal is discarded on gob piles because it is not properly separated from impurities.
- (17) Old inferior rolling stock causes losses of fine sizes along roadways and on planes. The coal becomes mixed with motor sand and is wasted.
- (18) In mines paying by weight, cars are loaded too high and coal rolls off in the headings. It mixes with impurities and is discarded on the gob.
- (19) In districts where shooting off the solid is common practice much coal is lost by being pulverized and scattered over the floors and gob piles by large shots.
- (20) Squeezes induced by rib gouging in both machine and pick mines are common cause of loss.

(21) Prohibitive cost of unwatering low areas in mines flooded during idle periods causes loss of pillars and solid coal.

(22) Small companies often abandon areas of coal because retreat plans have been delayed and timbers have rotted. The cost of cleaning up roof falls and retimbering is prohibitive to recovery of the coal.

(23) In some districts cars are wrecked on long outside planes and coal is not reloaded.

(24) Fine sizes of coal sift through tipples when the cars are dumped and are carried away by rain and wind.

(25) Thick binders or partings near the top or bottom of a coal bed are often left in place and used as roof or floor; the coal above or below them is lost.

(26) Many beds have thin benches of coal on the top or bottom. Removing the shale between these benches and the main part of the bed would increase the cost of mining so much that the thin benches are not mined.

(27) Unnecessarily large quantities of coal are left on the top to hold up bad roof. Adequate timbering would eliminate much of this loss.

(28) In some districts, where top coal is left in place, it is supposed to be recovered when pillars are pulled. Miners neglect to pick it down and the break comes before it is recovered.

(29) It is common practice in practically all of the districts not to clean up the floors of the rooms before the break comes, and much loose coal is lost.

(30) When pillars are pulled, unnecessarily large stumps are left; if they are not drawn at once, they are crushed by the break and the coal is lost.

(31) Lack of uniformity in size of rooms and pillars often causes local squeezes and heaves.

(32) When the price of coal is low and competition is great, operators leave large quantities of good crop coal because of its rusty and weathered appearance.

(33) Large areas of coal are abandoned as unmineable because in the evidence of drill holes the coal is thin. This may be a very local condition.

(34) Before the price of coal increased during the war it was common practice to discard fine sizes because the market demand was entirely for lump.

(35) Unsystematic pillar pulling or pillar grabbing in some mines has caused large areas to squeeze, and the roof to ride over large areas of solid pillars.

(36) The unavoidable loss of coal in reservation pillars under towns, streams, railroads, and buildings, and around oil and gas wells, is very great in the thickly populated parts of western Pennsylvania.

(37) In all districts large pillars are left between property lines. In the eastern districts the properties are small and the quantity of coal in the property barriers is large. These property barriers are seldom recovered because no two properties are worked out at approximately the same time. One-half of this barrier must be left for protection of the other mine.

(38) In order to produce coal quickly and in the largest quantity possible, operators take entirely too much coal on first mining.

(39) In some districts where union men refuse to work coal of certain height without extra pay, operators leave this coal in preference to paying the increased wage.

(40) Some binders or partings are water carriers. In mines having a water carrier parting or binder near the bottom, adjacent coal is left in place to avoid the water.

(41) Extraction of clay under coal beds wastes much of the overlying coal because large pillars are left when mining the clay.

(42) In some districts the union prevents the operators from having a mobile labor force. An operator must allow a room to stay idle three days before he can put another man in it. The operators sometimes have difficulty in removing a man from his place when his work is desired in another.

CONCLUSIONS.

(1) The percentage of recovery of coal in the bituminous fields of Pennsylvania is increasing each year as the great value of the coal resources is better realized.

(2) Percentage of recovery is increasing more rapidly in areas mining thick beds of coal. The percentage of recovery of Pittsburgh coal, which is adapted to special uses in various districts, is increasing rapidly.

(3) The use of fine sizes is becoming more prevalent and demand is increasing for sized coal.

(4) The percentage of recovery in Pennsylvania bituminous fields will probably increase to 80 or 85 per cent by 1935.

(5) Longwall methods will probably be installed in many localities when the thinner beds are mined, particularly those having a solid roof that breaks well.

(6) Non-mobile labor and charges for yardage have had detrimental effect on the recovery of coal.

(7) Low percentages of recovery are primarily results of economic conditions.

(8) Competition between various districts and other States has resulted in lowering the price of coal, thus preventing profitable recovery of "high cost" coal.

(9) The best recovery is in mines owned or operated by large corporations using their own product.

(10) Pennsylvania has the second highest recovery in the United States; West Virginia is first.

(11) The loss of coal in beds that have been undermined is less than is commonly believed. After investigating many properties where the beds have been undermined the writer has come to the following conclusions:

If a coal bed is mined out and the strata above it are allowed time to reach an equilibrium the injurious effects to the upper bed are minimized. If the pillars in the lower bed are pulled clean the upper bed is not as much affected as it would be if some of the pillars in the underlying bed were left. The effect of undermining upon overlying beds depends greatly upon the physical character of intervening strata and the nature and number of fracture lines.

In the Somerset district the Redstone coal, from 17 to 28 feet above the Pittsburgh, is being mined with great success after the Pittsburgh has been mined out. In the Cambria district beds have been mined after coal has been removed in underlying beds. The upper beds have been fractured, the bottom is locally heaved, and the roof cracked, and in rare instances the roof is floating (broken loose and dropped). The coal in these beds can be recovered with a possible 10 per cent increase in loss providing, of course, that the market price is sufficient to warrant the increased production cost due to extra timbering and maintenance of equipment. Other specific instances of coal beds being mined after the underlying bed has been worked out are treated in the district reports.

(12) The average operator does not avail himself of the opportunity to increase the percentage of recovery in his mine when the

price of coal is higher than the average. Rather, he opens up new areas of virgin coal in order to increase tonnage and take advantage of the rise in price.

SUMMARY OF COAL LOSSES.

The United States Geological Survey estimated that the bituminous coal production in Pennsylvania for 1921 was 116,000,000 tons. The coal lost during that year amounted to 46,400,000 tons, of which 25,100,000 tons was avoidably lost, and 21,300,000 tons was unavoidably lost.

The average yearly production of bituminous coal in Pennsylvania during the last twenty years was 170,000,000 tons. Assuming that the same percentage of coal was lost in each of the last twenty years, as given in the preceding tables, 68,000,000 tons of coal have been lost each year. Of this quantity 37,000,000 tons was avoidably lost, and 31,000,000 tons was unavoidably lost.

Summary of bituminous coal losses in Pennsylvania.†

	Total	Avoidable
On roof and bottom	4.5	2.8
In room, entry, and panel pillars	14.7	8.9
In oil and gas well pillars	*	
In boundaries, under buildings, railroads, and streams	1.3	0
In handling, and preparation, underground and surface	3.9	1.9
In roly, thin or dirty areas	4.2	1.9
	28.6	15.5

†The figures in this and following tables of coal losses represent the per cent of the original deposit lost in various ways.

*The coal lost in oil and gas well pillars in Pennsylvania is restricted to four districts in the western part of the State and at mines for which data was obtained amounted to 0.3 per cent or 170,000 tons.

CHAPTER III

COAL RESERVES.

The Topographic and Geologic Survey of Pennsylvania completed an estimate of the bituminous coal reserves of the State in July 1922. The work was done under the direction of John F. Reese, mining engineer and geologist. Nine months were spent in this work and the investigation covered every phase of the problem. Since the completion of Mr. Reese's estimates additional information has been collected and has been used in the recalculation of the coal reserves for this report. The estimates given herein are based upon the estimate of Mr. Reese.

The following quotation is taken from Mr. Reese's bulletin No. 54, of the Topographic and Geologic Survey of Pennsylvania:

“Earlier estimate. In 1909, M. R. Campbell* of the U. S. Geological Survey estimated that the bituminous areas of western Pennsylvania have an extent of 14,200 square miles and contained, when mining first began, 112,574,000,000 short tons. He figures that the supply remaining at the close of 1907 was 109,804,000,000 tons, or 492 times the exhaustion represented by the production of that year.

“Present estimate. To be of real value, an estimate of coal reserves must be based on all available data. In preparing this estimate, facts regarding the extent, thickness, and character of the coal beds were assembled from many sources, and the computation was taken up by counties.

“For each county on which a detailed estimate has been prepared, a base map was made for each local bed by tracing its outcrop from the latest maps available. All available measurements of a coal bed were plotted on the map of that coal bed at the locality represented. By studying the distribution of the figures, areas of equal thickness were plotted, and by means of a planimeter, the area of each coal bed in each township was measured. The unit used for calculating the quantity of coal was 90,000 short tons per inch of bed per square mile of area.

“Having calculated the quantity of coal originally contained within the area of any bed and subtracted the area already mined out, the writer determined from engineering experience the probable percentage of each bed which could be recovered in different locali-

*U. S. Geological Survey Bulletin 394, p. 23, 1909.

ties. The quantity of coal computed to be in any bed, multiplied by the assumed percentage of recovery, less 15 per cent for loss in mining, gives the estimated recoverable tonnage."

Bituminous coal reserves in Pennsylvania in short tons.

County	Original Deposit	Mined Out	Recoverable
Allegheny	3,180,400,000	969,200,000	1,486,900,000
Armstrong	3,750,700,000	107,290,000	2,491,100,000
Beaver	1,116,400,000	1,400,000	560,000,000
Blair	61,900,000	11,900,000	25,000,000
Bradford	39,000,000	300,000	19,000,000
Butler	4,550,000,000	30,000,000	2,300,000,000
Cambria	5,383,000,000	466,900,000	3,638,080,000
Cameron	42,000,000	100,000	20,000,000
Centre	422,000,000	60,000,000	184,000,000
Clarion	1,817,000,000	37,000,000	1,059,000,000
Clearfield	3,992,000,000	308,210,000	2,165,400,000
Clinton	93,000,000	5,000,000	44,000,000
Elk	610,000,000	27,000,000	297,000,000
Fayette	5,229,734,000	899,544,000	2,604,400,000
Greene	10,330,094,000	42,490,000	7,011,400,000
Indiana	6,339,400,000	299,200,000	4,288,700,000
Jefferson	3,420,000,000	180,000,000	1,900,000,000
Lawrence	611,000,000	300,000	311,000,000
Lycoming	68,000,000	200,000	34,000,000
Mercer	368,000,000	40,000,000	172,000,000
McKean	320,700,000	300,000	136,000,000
Somerset	6,091,800,000	187,384,000	3,986,900,000
Tioga	124,400,000	23,200,000	52,000,000
Washington	10,526,023,000	557,763,000	5,481,680,000
Westmoreland	6,381,504,000	1,218,141,000	3,297,500,000
Broad Top Field	391,000,000	46,843,000	265,800,000
	75,259,055,000	5,519,665,000	43,830,860,000

The writer has divided the reserves to conform with the district lines as shown on the district map on page 18 of this report.

Bituminous coal reserves in Pennsylvania in short tons.

District	Original Deposit	Mined Out	Recoverable
Pittsburgh Gas Coal	11,270,633,900	1,081,737,600	5,815,097,845
Beaver-Mercer	5,735,400,000	65,700,000	2,883,000,000
Pittsburgh Coking Coal	13,864,055,600	1,453,534,400	8,272,447,889
Allegheny-Clarion	8,877,191,500	328,152,500	5,347,325,000
Pittsburgh Steam Coal	7,046,297,000	864,599,500	3,847,743,000
Indiana	5,187,404,000	235,142,000	3,552,316,666
Ohio-Pyle-Ligonier	1,765,778,000	61,081,000	1,047,099,999
Somerset	5,674,100,000	137,784,000	3,721,600,000
Jefferson-Elk	5,611,000,000	253,800,000	3,107,240,000
Broad Top	391,000,000	46,843,000	265,800,000
Tioga	124,400,000	23,200,000	52,000,000
Clearfield	5,212,500,000	469,110,000	3,022,360,000
Cambria	3,972,700,000	487,000,000	2,638,780,000
	74,732,460,000	5,507,684,000	43,572,810,399
Small outlying districts not discussed in this report	526,595,000	11,981,000	258,049,601
Total	75,259,055,000	5,519,665,000	43,830,860,000

CHAPTER IV

PITTSBURGH STEAM COAL DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

The Pittsburgh steam coal district lies in the extreme western part of Pennsylvania. The city of Pittsburgh is in the center of the district. All of Allegheny County with the exception of Snowden, Jefferson, Elizabeth, and Lincoln townships, and that part of the county lying north of Ohio and Allegheny rivers, is included in the district; also the northwestern half of Washington County; and Franklin township of Westmoreland County.

GEOLOGY.

There are at least twenty coal beds in this district, two of which are mined extensively for shipping coal, viz: Pittsburgh and the Upper Freeport. The Redstone is mined locally for domestic fuel. The remainder of the beds are either too thin to be mined, or lie so deep beneath the surface that they cannot be commercially operated at the present time. The Sewickley and Waynesburg coals are mined at a few country banks in Washington County.

Generalized section of coal beds in Pittsburgh Steam Coal District.

	Name of bed	Average interval in feet	Range in thickness of coal beds
Monongahela 330	Waynesburg	90	0 — 3' 0"
	Uniontown	130	0 — 1' 0"
	Sewickley	40	0 — 3' 6"
	Redstone	70	6" — 5' 0"
	Pittsburgh (Lower Div.)	100	3' 6" — 9' 0"
	Little Clarksburg	85	0 — 2' 0"
Conemaugh 625	Wellersburg	80	0 — 2' 0"
	Duquesne	28	0 — 3' 0"
	Harlem	90	0 — 2' 9"
	Bakerstown	120	0 — 2' 8"
	Brush Creek (Gallitzin)	50	0 — 2' 6"
	Mahoning	72	0 — 2' 0"
	Upper Freeport	45	2' — 10' 0"
Allegheny 290	Lower Freeport	50	0 — 2' 0"
	Upper Kittanning	40	6" — 2' 0"
	Middle Kittanning	35	0 — 2' 0"
	Lower Kittanning	80	0 — 2' 6"
	Clarion	35	0 — 2' 0"
	Brookville		0 — 2' 0"

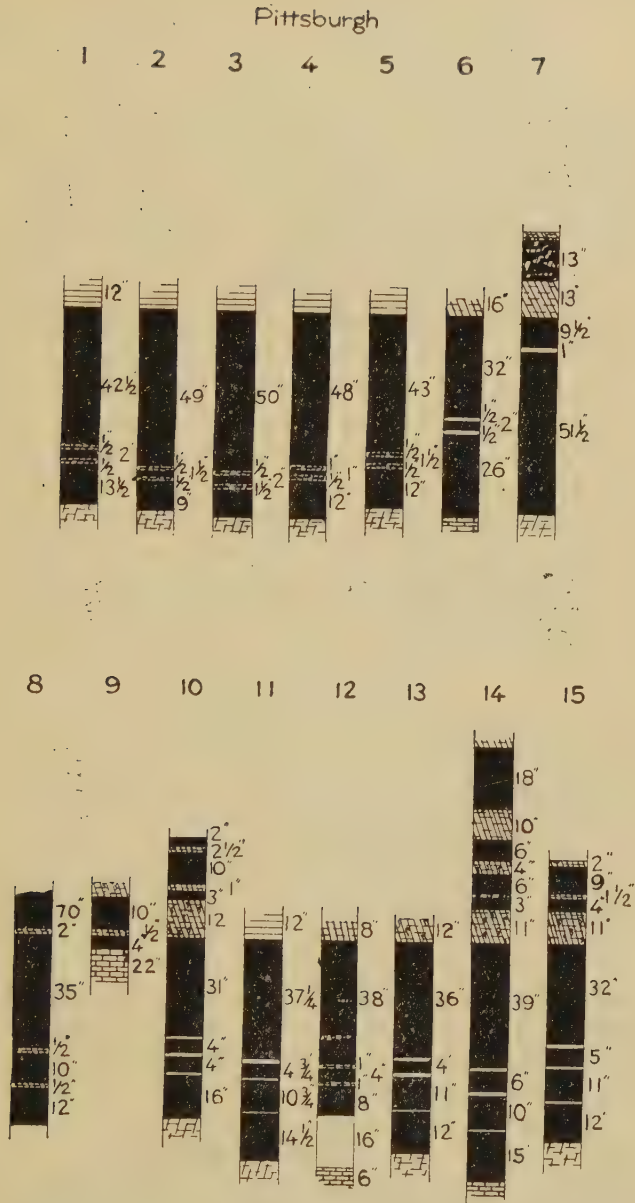


Fig.1 Sections of coal beds in operating mines in the Pittsburgh Steam Coal District, Pa.

DETAILED DISCUSSION BY BEDS.

Coals in the Allegheny and Conemaugh Groups.

These coals are far below the surface and do not outcrop in this district. Information concerning them is based entirely on data obtained from drill records. These data are limited and inadequate since most of them are from churn drill records which do not give a section of the coals. The drillers, who are primarily concerned with oil and gas horizons, often fail to record coals.

Two coals of workable thickness have been recorded in drill records, one at the approximate horizon of the Freeport coals, and the other at the horizon of the Kittanning group of coals. At present this Survey has little information as to their thickness and persistence. Rumors among the coal fraternity would indicate that the large companies, who have bought up considerable acreages in the district, are holding these coals as a reserve for future use. This is quite possible, for a locality containing the Allegheny group usually has at least one valuable coal, and may have several. Again, these coals are important in adjoining areas, and it is unlikely that all of them would become thin and unmineable within a few miles.

Conemaugh Coals.

Harlem coal. This bed lies just below the Ames limestone in the Conemaugh group. It outcrops in the extreme northwest part of the district, with a thickness of 18 inches. It is geologically the lowest coal outcropping in the district.

A local bed lying 15 to 30 feet above the Ames limestone, is 3 feet thick near Murdocksville, and has been opened in several places.

Little Clarksburg coal. This bed is locally mineable in the northwest part of the district, where it is known as the Bavington coal, because of its exceptional thickness at that place. In a small area southwest of Frankfort also it is thick enough for mining. The coal is dirty and very lenticular.

Allegheny Coals.

The greatest coal reserve is in the Allegheny group, containing the Kittanning and Freeport coals. This group outcrops on Allegheny River north of Pittsburgh and on Pine Creek in the north central part of the district, but lies deep under the remainder. The quality and thickness of its coals are known by private concerns that have tested their properties with core drills. Unfortunately there is little public information available.

Brookville and Clarion coals. These coals are known only from drill records. They are thin, averaging less than 12 inches each, and have a local maximum thickness of 2 feet. They are either lacking in large parts of the district, or their horizons are marked by several feet of bituminous shale.

Kittanning coals. These beds, lying under deep cover in practically all the district, are known only from drill records. They are thin wherever they have been identified. The Lower Kittanning is the most promising bed, but averages only about 12 inches thick where found. Locally it is 2 feet 6 inches thick and may be workable. The Middle and Upper Kittanning coals are thin and insignificant.

Upper Freeport Coal.

Distribution and character. The Upper Freeport coal outcrops in the northeast corner of the district on Allegheny River. The coal ranges from 2 to 10 feet thick. Where thickest 2 feet of cannel coal is commonly present at the top. A shale and bone parting varying from $1\frac{1}{2}$ inches to 2 feet thick is usually present about 2 feet from the top. When this parting exceeds 14 inches, the upper bench is not mined, and the parting is left as roof. Two binders of bony coal are invariably present, one about 5 inches, and the other 12 inches from the bottom. Often the upper binder is used as a floor, and the two thin underlying benches of coal are not mined.

The Upper Freeport is a friable coal, composed of alternating bright lustrous and dull resinous bands. The lower part of the bed is blocky, the middle part is the stick variety, and locally the top is canneloid. The coal mines out in fair sized lumps. It averages about 33 per cent volatile matter, 56 per cent fixed carbon, 8 per cent ash, and 1.5 per cent sulphur. This coal is used almost exclusively for steam and domestic fuel. The first mines were opened about 1860.

Coal losses and mining methods. The Upper Freeport is being mined extensively in Penn and Plum townships, Allegheny County. The shafts are over 500 feet deep. These mines are comparatively new, and are worked very efficiently. Rooms and entries are all driven the same size as those in the Pittsburgh bed. Pillars have not been pulled in a few mines, but a fair recovery is indicated.

The roof of the Upper Freeport is hard sandstone and shale; the bottom is clay and limestone. The system of mining is entirely room and pillar.

The main, cross, and butt entries are 12 feet wide. The average net pillar width between main and cross entries is 30 feet. The side pillars are 40 feet wide. The room necks are 10 feet wide and 25

feet long. The rooms are generally driven 21 feet wide with 12 feet of pillar. The room break-throughs are 100 feet apart and 10 feet wide. The mining is 80 per cent machine.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	10	8
In room, entry, and panel pillars	20	14
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams ..	2	0
In handling and preparation, underground and surface ...	4	2
In roly, thin or dirty areas	5	2
	42	26

Pittsburgh Coal.

Distribution and character. The earliest record of bituminous coal mining in Pennsylvania is 1760, when, according to Captain Thomas Hutchins, a coal mine was opened on Monongahela River, opposite Fort Pitt, now Pittsburgh. From that date production grew, and Allegheny County was the largest producer of bituminous coal in Pennsylvania for many years. At the present time, the largest producer, the Pittsburgh coal, is rapidly approaching exhaustion in Allegheny County. However, the district has a large reserve of Upper Freeport and Kittanning coals.

The Pittsburgh is the best known, most valuable, and most persistent bed in this district. It has a total thickness, including clay and shale parting, of 4 to 12 feet, averaging about 5 feet. It is divided into four or five benches by clay or shale partings. Where thickest, the bed carries many partings. In much of the area a rider bed having a thickness from 6 inches to 7 feet occurs above the main bed. The main bed is 4 to 7 feet of good clean coal. Along Monongahela River the Pittsburgh bed is a coking coal; between the river and the Pidgeon Creek area it is a good gas coal. West of the gas coal belt it is a fine steam coal.

The Pittsburgh underlies practically all the district, is lacking only in a small area in the northwest, and in a few stream valleys. The outcrop is limited almost without exception to Hanover, Smith and Robeson townships in the northwest, and the townships bordering on the Monongahela. In these townships mining is by drift and slope; in the remainder of the district, where the coal is several hundred feet below surface, mining is by shaft. The bed is generally double, the roof and lower division being separated by a clay or shale parting, varying from a few inches to several feet thick.

The roof division is rarely clean enough to mine. It varies in thickness, and has many partings in addition to several inches of

bituminous shale at the top. This division usually consists of two benches, separated by clay; locally this clay thins and many alternating layers of impure shale and coal replace it.

In the river area the lower division is 3 to 10 feet thick, divided into four benches, by three persistent bone partings namely, the breast, the bearing-in, the brick, and the lower bottom coals. In the remainder of the district, particularly in the west, the small parting between the brick and lower bottom coals is lacking. A few inches of draw slate occurs above the breast coal.

The breast coal is the most regular and valuable bench of the lower division.

The bearing-in coal is thin and soft, and slacks when mined. It is often entirely discarded.

The brick coal has good quality, averages over 12 inches thick and mines out in brick-shaped blocks.

The lower bottom coal is not always a distinct bench, and is mined with the brick coal. The coal is inclined to be dirty, and rather high in ash and sulphur.

The Pittsburgh is the most important bed in Allegheny County. Generally the bed is double, consisting of a roof and a lower division, separated by a clay parting 1 inch to 3 feet thick containing thin bands of coal. The roof division ranges from 2 inches to 8 feet thick, increasing in thickness northward. Occasionally it is a single bench, but commonly it contains two or more benches of coal, separated by clay. The coal of the upper division is invariably poor, because of a large percentage of ash.

The Pittsburgh coal contains 57 to 65 per cent fixed carbon, 30 to 35 per cent volatile matter, 4 to 14 per cent ash, and the sulphur is usually 1 per cent.

Approximately 250 acres of Pittsburgh coal remains in Allegheny County between Ohio and Allegheny rivers. In that area the roof division has a maximum thickness of 6 feet, including partings; the main clay averages 8 inches; the lower division averages 5 feet, and is separated into three benches by very thin partings.

An enormous quantity of excellent steam and gas coal has been mined from the Pittsburgh bed between Youghioghony and Allegheny rivers. The roof division ranges from a few inches to 4 feet thick; the main clay is 12 inches thick. The lower division has an average thickness of 5 feet 6 inches and is divided into three benches.

Between Monongahela and Youghioghony rivers the roof division averages about 3 feet and is much parted. The main clay is 11 inches thick; the lower division averages 6 feet thick, and is divided into three benches.

South of Ohio River and west of Monongahela River the roof division is about 3 feet thick, where present, and has many clay part-

ings. However, the quality is locally good and the coal is mined and shipped. The roof division has been opened separately in several localities. The main clay averages 2 feet thick. The lower division is always over 5 feet thick and is divided by thin partings of clay or shale into four or five benches. In the deepest part of the Panhandle trench between Beadling and Hickman, the Pittsburgh bed was over 10 feet thick but thinned rapidly to both sides.

The roof of the Pittsburgh coal in the steam district is generally a mixture of bone coal and shale. A rider coal, ranging from 0 to 3 feet thick, is present above this bony and shale mixture. This coal is mineable in some parts of Washington County, but is almost entirely ruined due to mining the Pittsburgh beneath it.

The roof of the Pittsburgh coal is locally very treacherous and requires constant timbering. It air-slakes soon after the coal is removed. Where the roof is shale it is shelly and slickensided on the joints, and falls easily. In many places several inches of solid coal is left to hold up this roof. The bottom is limestone and clay. The clay is soft, but the limestone generally makes a good solid bottom.

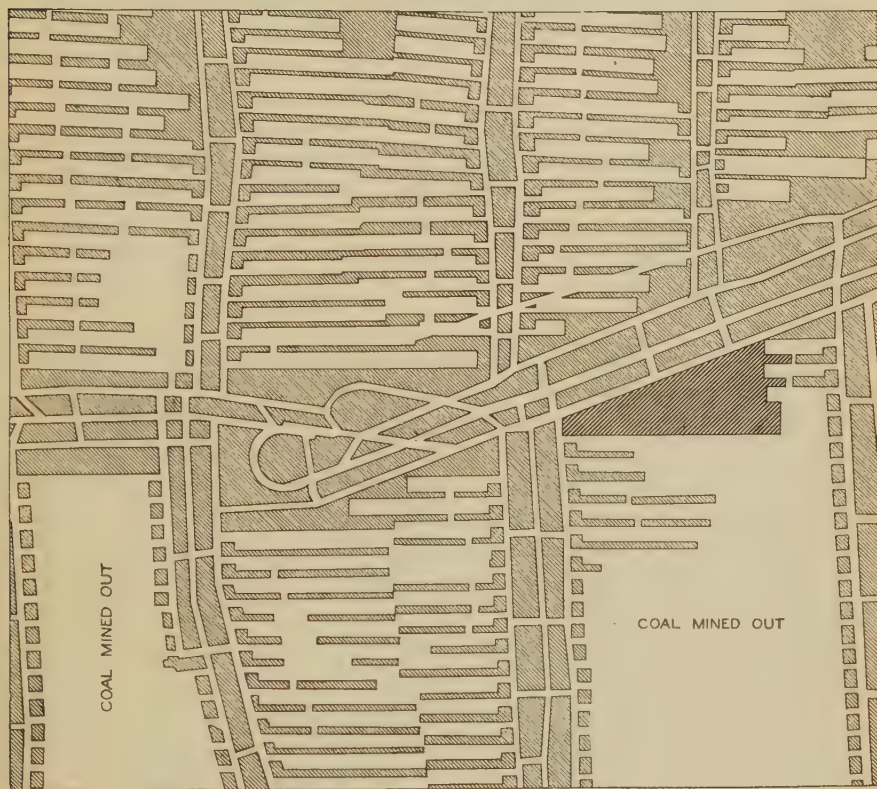
Coal losses and mining methods. In the southern part of the district in south Allegheny, and in Washington counties, the main, cross, and butt headings are driven 10 feet wide. In the northern part of Allegheny County they are generally only 9 feet wide. The pillar width between main entries varies from 30 to 50 feet. The side pillars vary from 30 to 75 feet wide. The room necks are generally 20 or 21 feet long and from 7 to 10 feet wide. The chain pillars vary from 20 to 40 feet wide. In Washington, and the southern part of Allegheny County, the rooms are driven on 41 foot centers, 15 feet of which is pillar. In the northern part of Allegheny County, principally along Monongahela and Allegheny rivers, the rooms are driven on 36 foot centers, room pillars being only 7 to 10 feet wide.

The room break-throughs are 100 feet apart, and 6 to 8 feet wide. Over 80 per cent of the mining is machine.

The first commercial mines in this bed were opened about 1850. The old National mine, Camp Hill, and Grant mines on the Panhandle Railroad were some of the earliest to be opened. Production from this district has been enormous and now the Pittsburgh coal is practically depleted in Allegheny County, work being limited principally to pillar pulling in old mines. However, many acres of virgin coal remain untouched in Washington County. The coal from this district is used almost exclusively for steam and domestic purposes, is shipped principally to the Lakes and used as railroad fuel.

The greatest loss in the Pittsburgh bed is in pulling pillars. In Allegheny County the mines are old and have been worked very unsystematically. Practically no attention was paid to the size of rooms and pillars, and the rooms and headings were not run on

sights. The pillars were gouged in many mines until only a few feet of coal remain between each room. Their pillars were crushed by the overburden before they could be removed. It was customary in the early days of mining to leave many large pillars, mining only the thick virgin coal, driving the rooms wide, never thinking of retreating. In these mines, a great number of which are now abandoned, no pillars whatsoever were pulled. The headings have now caved in and it is a commercial impossibility to recover this coal. The mining system is practically all room and pillar. The recovery in the Pittsburgh bed will not be much improved because the coal is



SECTION OF MINE MAP
Pittsburgh Steam Coal District

Virgin Coal Coal to be recovered
in whole or in part

Scale
200 100 0 200 400 Feet

FIGURE 2.

rapidly approaching exhaustion. The recovery percentage increased rapidly within the last fifteen or twenty years when the great value of the Pittsburgh bed was realized. Before 1900 or 1905 it was the custom to leave from 2 to 18 inches of top coal, and to use a minimum quantity of timbering. Many inches of bottom coal were also left because slightly inferior quality lowered the quality of the run-

of-mine shipments. Thousands of tons of small sized coal were discarded on inside and outside gobs when demand was slack and the market required lump coal. Practically all tracks were ballasted with coal, and immense quantities were discarded on the gob. When the roof fell it was easier to drive around than to clean up and recover coal behind. Before installation of modern pumping systems large areas were flooded, making the cost prohibitive to the recovering of unpulled pillars. Timbering was rarely replaced when part of a mine was cut off by extensive roof falls. Rarely was an attempt made to drive through it and recover the coal behind.

The mines in Washington and western Allegheny counties are younger than those in eastern and southern Allegheny County. However, the same system of mining prevailed in this part of the district until fifteen or twenty years ago. The operators saw many thousands of acres of virgin coal, averaging $6\frac{1}{2}$ feet, ahead of them, and drove their headings and rooms in all directions without any thought as to coal conservation. Rooms were also driven entirely too narrow, were consequently squeezed, and large areas of pillars lost. Gouging on the ribs often induced squeezes in areas of thick overburden. When mines were abandoned all the chain, barrier, and side pillars were lost.

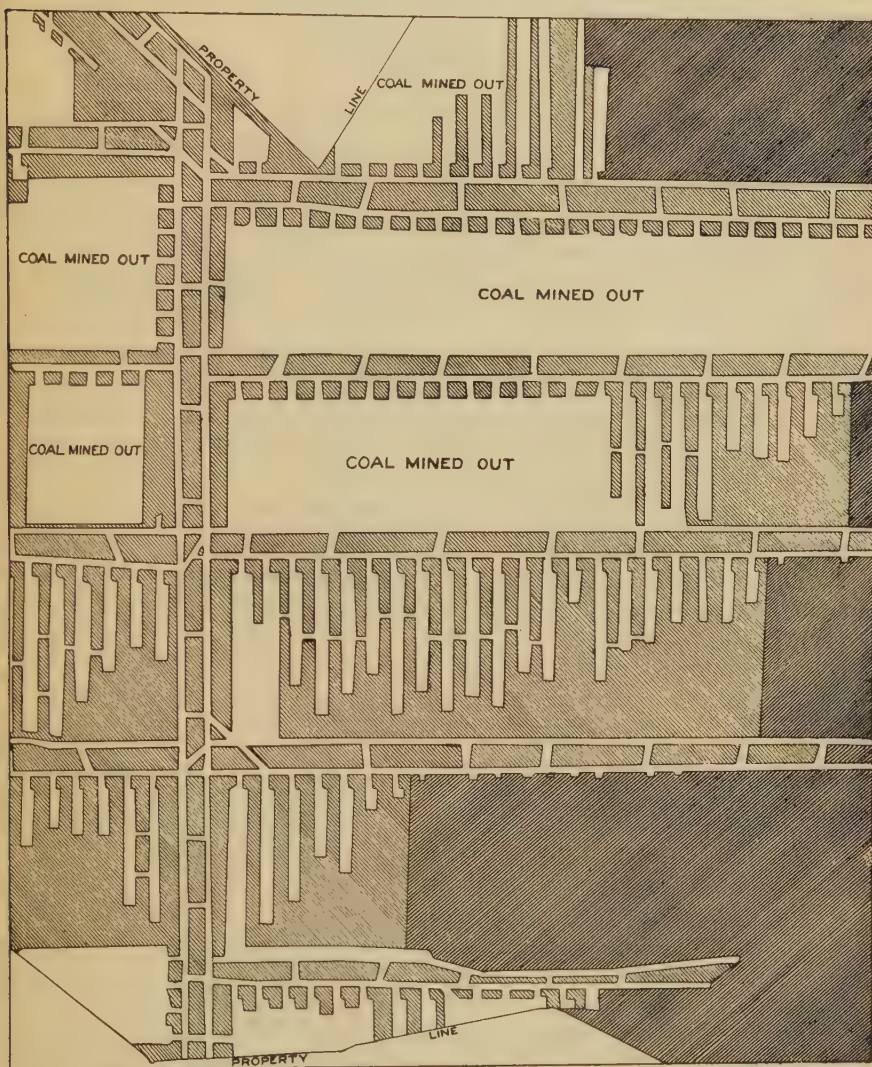
The greatest loss today in pillars is directly attributable to several causes. The rooms should be driven narrower, and should be kept on sights in order to prevent squeezes. Idle days by delaying retreat plans have caused the crushing of pillar ends. Pillars have been partially pulled and allowed to stand when there was no market for the coal; the remaining stumps have been covered by the break. During war time, operators drove too many rooms off their headings in order to momentarily increase production, causing squeezes covering large areas in several mines. Retreat plans were also delayed for two or three years when the demand was excessive and pillars were crushed and lost.

In Washington County particularly, bad roof condition in local areas necessitates leaving several inches of top coal which is only partially recovered when the pillars are pulled. The lower bench of the Pittsburgh is sometimes slightly inferior in quality, and the operators do not load it with their run-of-mine shipments, claiming that it lowers the quality. In some mines 18 inches of coal is left on the bottom; in others, where the coal is not inferior, 2 to 12 inches is left on the bottom by machine men. This is scrapped in some large mines, but the smaller operations leave it down.

The loss in handling and preparation is also excessive, chiefly caused by miners discarding coal on the gob, and by small sizes sifting through loose end-gates on cars. This coal is lost by discarding on gob piles after being mixed with the dirt and motor sand when

the headings are cleaned up. Track is ballasted with coal in a few of the smaller mines.

In the thickly populated areas large quantities of coal are unavoidably lost as pillar reservations.



SECTION OF MINE MAP
Panhandle District of the Pittsburgh Steam Coal District

Virgin Coal
 Coal to be recovered in whole or part

Scale
200 100 0 200 400 Feet

FIGURE 3.

In the western part of Washington County the roof is in bad condition and operators must leave large pillars to hold it up.

Coal losses in Pittsburgh bed.

	Per Total	Cent Avoidable
On roof and bottom	6	3
In room, entry, and panel pillars	12	6
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams, ..	1	0
In handling and preparation, underground and surface ..	4	2
In roly, thin or dirty areas	4	2
	28	13

The district is practically union. Operators do not have labor difficulties that lower the percentage of recovery. The labor force is mobile, and the miners do not refuse to perform certain labors, such as working low coal, provided that they are properly remunerated.

The district is very densely populated, and the labor is drawn from nearby towns and cities. Mining camps are few. In general, the living conditions in these towns and cities are very good. Practically all of them are equipped with up-to-date sewerage plants, and have ample supplies of good water.

An intimate field study was made of eight mines which fairly represented the entire district, both as to production and mining conditions. Maps and data of thirty other mines were studied in the office. Areas were calculated by planimeter and the loss checked against the production.

CONCLUSIONS.*Summary of coal losses in Pittsburgh Steam Coal District.*

	Total	Avoidable
On roof and bottom	6	3
In room, entry, and panel pillars	14	8
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams ...	1	0
In handling and preparation, underground and surface ..	4	2
In roly, thin or dirty areas	4	2
	30	15

CHAPTER V

PITTSBURGH GAS COAL DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Pittsburgh gas coal district is situated in the southwestern part of Pennsylvania, and includes parts of Greene, Washington, Fayette, Allegheny, and Westmoreland counties.

The gradation between the gas coal and coking coal on the eastern edge of this district is gradual as is the gradation between the gas coal and steam coal on the northwestern part of this district. The lines separating the Pittsburgh gas coal district from the Pittsburgh steam coal and Pittsburgh coking coal districts are therefore arbitrary, but the writer believes that these lines have been drawn with as much accuracy as is possible. The analyses of the U. S. Bureau of Mines and Pennsylvania Geological Survey have been taken into consideration, trade relations and coal types have also been studied in order to place these lines accurately.

The following townships are included in the Pittsburgh gas coal district. Richhill, Morris, Washington, Center, and the northwestern half of Aleppo in Greene County; East and West Finley, Buffalo, South Franklin, Morris, Amwell, West Bethlehem, Somerset, Fallowfield, Carroll, Nottingham, Union, and eastern half of Peters in Washington County; Snowden, Jefferson, Lincoln, and Elizabeth in Allegheny County; Rostraver, northern half of South Huntingdon, Sewickley, North Huntingdon, Hempfield, Penn, southern third of Franklin, Salem, Loyalhanna, and the northwestern fifth of Derry in Westmoreland County.

GEOLOGY.

The Pittsburgh gas coal district extends from the West Virginia State line northeast to Conemaugh River. It contains a series of anticlines and synclines running in a general northeast-southwest direction. The Pittsburgh coal, lying at the base of the Monongahela group, is the most important coal, and has long been used for producing gas as well as for steam and domestic purposes.

Mines were opened in this district before 1850. Portions of the district are now practically worked out, particularly the area in the vicinity of Irwin. The Pittsburgh coal is mined by drift, shaft, and slope practically everywhere in the district. The western part

of Greene and Washington counties is untouched, and has been prospected but meagerly. Large acreages of excellent gas coal probably will be developed in this area.

About twenty-five coal beds crop out in this district, three of which produce coal for shipment, four others are mined for farm use, and the remainder either have not been prospected sufficiently, or are too thin and impure, to be mined. The enormous value of the Pittsburgh coal has retarded investigation of the beds underlying it. These beds are generally under heavy cover, and with the Pittsburgh bed outcropping, or close to the surface, the financial venture has been too great to warrant opening the thinner beds.

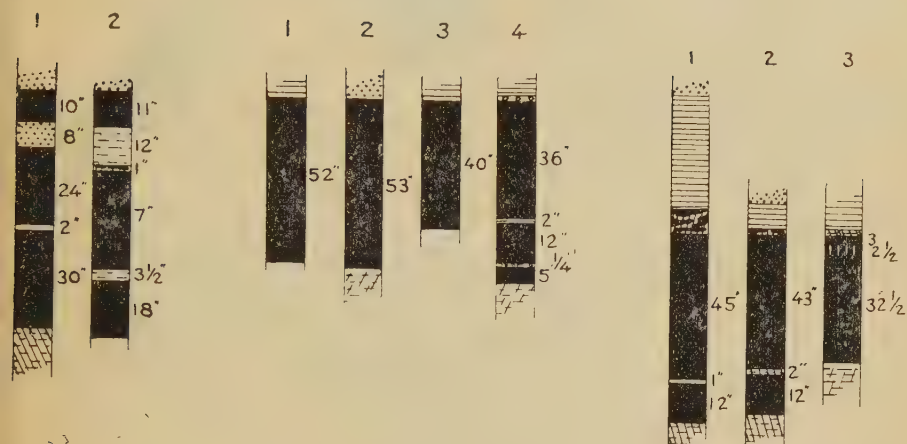
Generalized section of coal beds in Pittsburgh Gas Coal District.

	Name of bed	Average interval in feet	Range in thickness of coal beds
Monongahela 400	Washington	120	0 — 2' 0"
	Waynesburg	115	0 — 10' 6"
	Uniontown	145	0 — 2' 0"
	Sewickley	75	0 — 1' 0"
	Redstone	65	0 — 6' 6"
	Pittsburgh	280	5' 0" — 8' 0"
Conemaugh 645	Duquesne	35	0 — 1' 2"
	Harlem	60	0 — 4' 0"
	Bakerstown	170	0 — 7' 4"
	Brush Creek	45	0 — 1' 6"
	Mahoning	55	0 — 3' 0"
Allegheny 285	Upper Freeport ("E")	60	0 — 7' 2"
	Lower Freeport ("D")	50	0 — 2' 10"
	Upper Kittanning ("C")	40	0 — 5' 0"
	Middle Kittanning ("C")	40	0 — 5' 0"
	Lower Kittanning ("B")	60	0 — 5' 0"
	Clarion ("A")	35	0 — 3' 6"
	Brookville ("A")		0 — 5' 0"

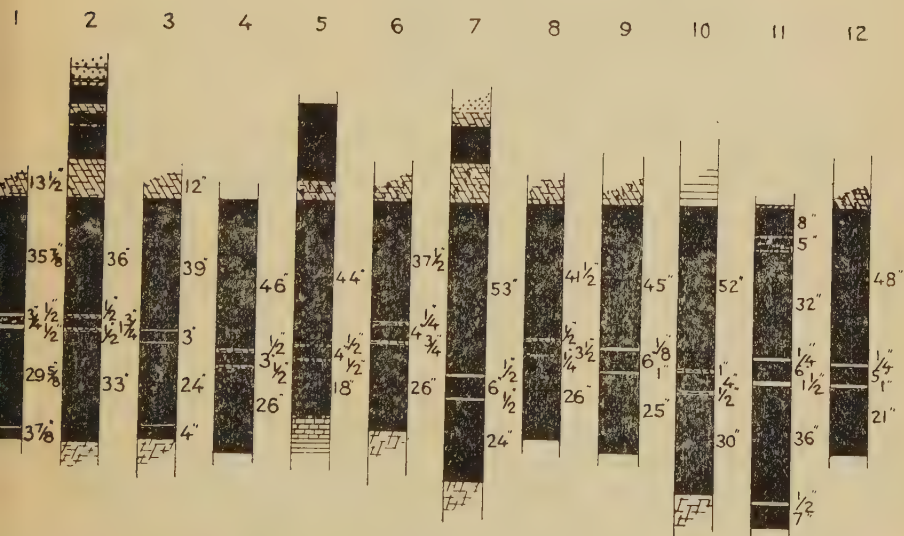
Waynesburg

Redstone

Lower Freeport



Pittsburgh



Scale 1" = 5'

Fig. 4 Sections of coal beds in operating mines in the Pittsburgh Gas Coal District, Pa.

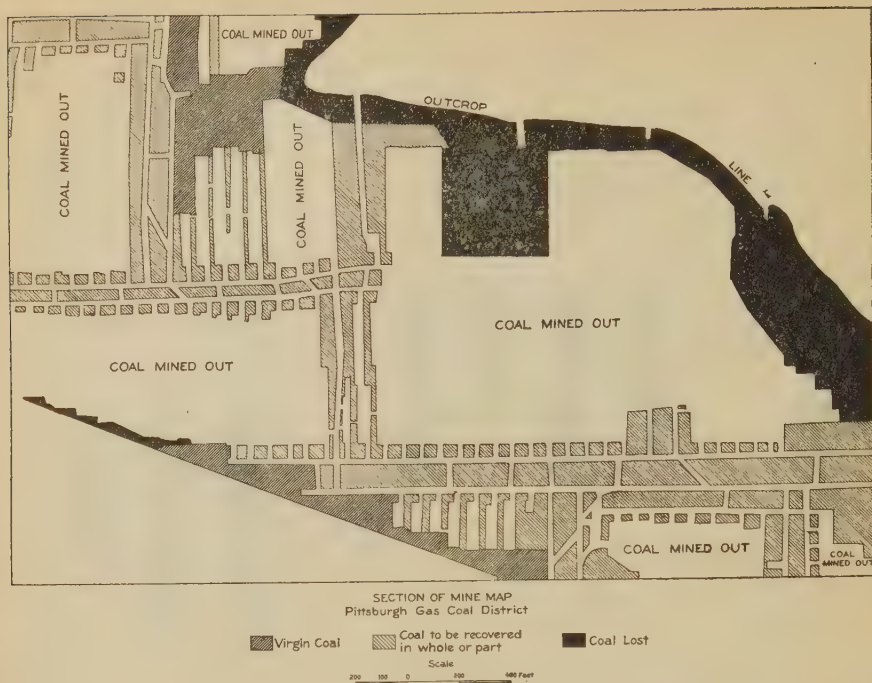


FIGURE 5.

DETAILED DISCUSSION BY BEDS.

Conemaugh Coals.

The Conemaugh group, underlying the Monongahela, is present in the basins, and on the flanks of the synclines.

Several thin coals in the Conemaugh have no commercial importance at present. These are, in ascending order: Mahoning, Brush Creek, Anderson, Bakerstown, Harlem, Duquesne, Wellersburg, Little Clarksburg, and Little Pittsburgh. Of these, the Mahoning, Brush Creek, Harlem, and Duquesne may be mined locally in the future, when the thicker beds are worked out.

Mahoning coal. About 55 feet above the Upper Freeport is a dirty bed of coal, nowhere over 4 feet thick, that has been used locally for house fuel. It contains one main shale parting near the middle and several thin ones scattered through the bed. The Mahoning coal averages 33 per cent volatile matter, 52 per cent fixed carbon, 10 per cent ash, and 3 per cent sulphur.

Brush Creek coal. A bed found 45 to 60 feet above the Mahoning coal has been correlated as the Brush Creek. It is a thin coal of good quality and has been mined in many places for house fuel. It averages 12 inches thick, has no partings, and is low in sulphur and ash.

Bakerstown coal. The Bakerstown coal, lying about 60 feet below the Harlem coal, is very irregular in thickness and commonly is thin. The bed is thickest $4\frac{1}{2}$ miles southwest of Greensburg on Little Sewickley Creek where it has been mined and mistaken for the Upper Freeport. Here it is composed of 5 feet of soft coal, 16 inches of cannel coal, and 12 inches of bony coal. The coal has 32.7 per cent volatile matter, 44.9 per cent fixed carbon, 20 per cent ash, and 2.6 per cent sulphur.

Harlem coal. This bed, lying about 315 feet below the Pittsburgh, averages 1 foot thick, with a local maximum of 4 feet. The coal is excellent for smithing and steam purposes and has been used more than any other Conemaugh coal for house fuel.

Duquesne coal. This bed has been recorded only in the western part of the district, where locally it is over 12 inches thick. It appears to be good coal but has been little used.

These coals are mined only for local use by the farmers. The mines produce only a few tons a year, and will not be considered in the estimates of coal losses.

Allegheny Coals.

The coals in the Allegheny group, including the Freeports and Kittannings, are under heavy cover practically everywhere in the district. They have been tested locally by diamond drill, and in several localities have proven to be thick and merchantable. With the exhaustion of the Pittsburgh bed these coals will come into prominence. There are practically no openings in these beds at the present time.

Kittanning coals. The Kittanning coals lie deep under most of the Irwin basin, and are known only from diamond drill records. The Upper Kittanning appears to be absent; the Middle Kittanning is thick enough to mine in large areas; the Lower Kittanning is thin, lenticular, and only locally mineable.

The Middle Kittanning bed is 1 to 5 feet thick $1\frac{1}{4}$ miles west of Salina; 2 feet 10 inches thick in southeastern Franklin township; 3 feet 8 inches thick in northeastern North Huntingdon township; and 3 feet 7 inches thick in northern Sewickley township. These thicknesses may be local.

The Lower Kittanning coal is 2 feet thick in southern Franklin township; 2 feet 2 inches thick in North Huntingdon township; and 2 feet 10 inches thick in northern Sewickley township. It is either very thin, or entirely lacking in Rostraver township.

Lower Freeport coal. This bed is lenticular, and is rarely over 12 inches thick in the district.

Upper Freeport coal. The Upper Freeport is the most important coal in the Allegheny group in the Irwin basin. In Allegheny, Washington, Bell, and Loyalhanna townships, it ranges from 3 feet to 4 feet 4 inches thick and generally is clean, except for local bone partings. In Upper and Lower Burrell townships the bed ranges from 3 feet 6 inches to 5 feet 8 inches thick, is very dirty locally, and carries several bone and shale partings in addition to a few inches of bony coal at the top.

The Upper Freeport is faulted out by sandstone in southern Washington and northern Salem townships; in all of Franklin but the northwestern corner; all of Penn township; in northern Hempfield; and southern North Huntingdon township.

In Sewickley township the Upper Freeport ranges from 2 feet to 4 feet 2 inches thick, and usually carries two or three clay and shale partings. The bed has a local maximum thickness of 6 feet in Rostraver township.

The Upper Freeport coal in the Irwin basin averages approximately 33 per cent volatile matter, 55 per cent fixed carbon, 8 per cent ash, and 2 per cent sulphur. It is a soft, friable coal that breaks up when mined.

Coals above the Pittsburgh Bed.

The Pittsburgh bed is now the most important coal in the county. At the present rate of exhaustion it will last hardly 20 years. That fact has led the coal companies to prospect the thin coals lying above the Pittsburgh bed.

Pittsburgh Rider Coal. This bed, which directly overlies the Pittsburgh bed, locally is over 2 feet thick, but is very shaly. It is never mined and gives little promise of future utilization.

Redstone coal. This bed is about 65 feet above the Pittsburgh bed. It has been mined extensively for house fuel, and during war time for shipment. At present it is mined for shipment in a few places. Its occurrence is restricted to the hills in the basins. North of the main line of the Pennsylvania Railroad the coal is very thin and is entirely lacking in large areas. It averages less than 2 feet thick, but it thickens south toward Youghiogheny and Monongahela rivers, and in some places is over 5 feet. The coal is generally good, and the bed is free from partings, with the exception of a local 3-inch clay band near the top. Roof and bottom rolls are common.

The Redstone coal probably is thickest and best in the townships south and southwest of Greensburg. South of Madison Station the bed is 6 feet 6 inches thick, with a 3-inch clay parting in the upper half. In Sewickley township it is 4 feet thick in many places. The

bed varies greatly in Hempfield township, but it has been opened in many places, and will be in demand in the future. In North Huntingdon township the bed ranges from 6 inches to 2 feet 6 inches thick and has been opened for house fuel.

In the vicinity of Hackett and Finleyville the Redstone has been opened in many country banks, and has a maximum thickness of 3 feet 4 inches. In Scotts Hollow, on Pidgeon Creek, it has been mined in two benches 18 and 21 inches thick. Above Lock No. 4, on the Monongahela, the coal is 4 feet thick, and is of excellent quality. Just above Black Diamond mine, along the Monongahela in Carroll township, it is 2 to 3½ feet; near the mouth of Mingo Creek the bed has a regular thickness of 4 feet.

The Redstone coal has good quality in this region, and is second in importance to the Pittsburgh. The percentage of fixed carbon is high, the volatile matter is medium, and the ash and sulphur content only slightly exceeds that of the Pittsburgh coal.

The Redstone coal has probably been ruined over large areas by mining the Pittsburgh coal beneath it. In a few country banks which the writer has visited the Redstone bed is badly crushed and fractured. The bottom has been heaved and the roof cracked. The coal is discolored by surface waters seeping through the cracks made when the pillars in the Pittsburgh bed were pulled. The water from the Redstone coal in these mines drains down into the old Pittsburgh workings.

The Redstone coal is very variable in thickness, and it will probably be several years before any extensive development takes place in it. By that time the Pittsburgh will be entirely worked out beneath it and a partial equilibrium established, enabling the possible recovery of 50 or 75 per cent of the Redstone.

Sewickley coal. This bed has an average interval of 140 feet above the Pittsburgh bed. It is a very dirty bed restricted to the hilltops of the Greensburg basin, and has never been mined.

Benwood coal. A coal lying between the benches of the Benwood limestone in the Greensburg and Irwin basins averages about 12 inches thick, and has been opened at one point, where it is over 3 feet thick. It is lenticular and varies greatly in thickness within a few hundred feet.

Uniontown coal. This bed, occurring about 285 feet above the Pittsburgh, is thin in Westmoreland County. It is probably thickest in townships bordering Monongahela River. It has not been prospected, but its outcrop indicates that it is very impure.

Waynesburg coal. The Waynesburg bed is present in the townships bordering Monongahela River. Here it has a maximum thickness of 10 feet 6 inches and has been mined for local use. The coal

is extremely impure and the bed carries many clay and bone partings. It is thinner on Sewickley Creek, but has better quality, and has been mined.

Washington coal. This bed is present only in the highest hill tops in the southern part of the Irwin basin. The coal is soft and impure. It has been opened by farmers but probably will never be mined extensively.

Pittsburgh Coal.

Distribution and character of Pittsburgh coal in Greene, Washington and Allegheny Counties. This bed is the best known, most valuable, and most persistent coal in Washington County. It has a total thickness, including clay and shale partings, of 4 to 12 feet, averaging about 5 feet. It is divided into four or five benches by clay or shale partings. In much of the area a rider bed having a thickness from 6 inches to 7 feet occurs above the main bed. The main bed is 4 to 7 feet of good clean coal. Along Monongahela River the Pittsburgh bed is a coking coal; between the river district and the Pidgeon Creek district it is a good gas coal. West of this gas coal belt it is a fine steam coal.

The Pittsburgh coal underlies nearly all of Greene, Washington and Allegheny counties, and is lacking only in a small area in the northwest part of this area and in a few stream bottoms. The outcrop is limited almost entirely to Hanover, Smith, and Robeson townships in the northwest, and the townships bordering on the Monongahela. In these townships mining is by drift and slope; in the rest of the district in Washington County, where the coal is several hundred feet below the surface, mining is by shaft. The bed is double almost everywhere, the roof and lower divisions being separated by a clay or shale parting, varying from a few inches to several feet in thickness.

The roof division is seldom clean enough to mine. It varies in thickness, and carries many partings in addition to several inches of bituminous shale at the top. This division usually consists of two benches, separated by clay; locally this clay thins and many alternating layers of impure shale and coal take its place.

In the river district the lower division of the bed is 3 to 10 feet thick, divided by three persistent bone partings into four benches, namely, the breast coal, the bearing-in, the brick, and the lower bottom coal. In the remainder of the district, particularly in the west, the small parting between the brick coal, and the lower bottom coal is lacking. A few inches of draw slate comes in over the breast coal.

The breast coal is the most regular and valuable bench of the lower division.

The bearing-in coal is thin and soft, and falls into slack on mining. It is often entirely discarded.

The brick coal is of good quality, averages over 12 inches thick, and mines out in brick-shaped blocks.

The lower bottom coal is not always a distinct bench, and is mined with the brick coal. The coal in this bench is inclined to be dirty, and rather high in ash and sulphur.

Pittsburgh coal in Westmoreland County. The lower division of the Pittsburgh coal averages 6 feet 6 inches thick in the Irwin basin of Westmoreland County. It is divided into four benches by thin bony coal partings. The top bench is called the breast coal, and is from 3 feet 6 inches to 4 feet thick; a thin bone parting separates the breast coal from the bearing-in bench, which is from 4 to 6 inches thick. The brick coal is about 18 inches thick, and is separated from the bearing-in coal and the bottom coal by thin bone partings. The bottom coal is impure, and rarely mined.

The lower division of the Pittsburgh coal averages 6 feet 4 inches thick in the townships north of the main line of the Pennsylvania Railroad, but thins to an average of 5 feet 10 inches in the townships south of that line. In the southern and western parts of South Huntingdon township, it locally averages 7 feet 1 inch thick.

The Pittsburgh coal in the Irwin basin is soft and friable. It ranges from 32 to 36 per cent volatile matter, averaging 33 per cent; 53 to 58 per cent fixed carbon, averaging 56 per cent; 6 to 9 per cent ash, averaging 7.5 per cent; .8 to 1.5 per cent sulphur, averaging 1 per cent.

The first mines on the Monongahela were opened before 1840. In the year 1844 the Monongahela Navigation Company's system of locks was completed to Brownsville. With the completion of these locks the coal industry along Monongahela River was given a great impetus, and shipment by barge to Pittsburgh, and down the Ohio River began. The Youghiogheny slack water system was completed in 1850 (this system is now abandoned), and the construction of the Baltimore and Ohio Railroad opened up the district along Youghiogheny River.

In the early days of the coal industry only about 50 per cent of the Pittsburgh coal in this part of the district was recovered. It was customary to ship only the lump coal, discarding the small sizes. To minimize timbering, head coal varying from 4 to 18 inches thick was left up. The bottom bench, which is slightly inferior coal, was never removed. The rooms were driven wide, and frequent squeezes ruined large areas. Little attempt was made to pull pillars. Without modern methods of pumping mines, the water problem was exasperating. Large areas of coal were completely lost by flooding.

These old workings have now caved in and it is an utter impossibility to recover the coal which was butchered in the early days. After 1900 the operators took more pride in cleaner recovery and in running their headings and rooms on sights. The top and bottom coal was still lost in some instances, but pillar pulling was more generally practiced. After 1910 the percentage of recovery increased to approximately 70 per cent. In the last few years the mining systems have improved materially, pillars are being pulled, and a smaller percentage of top and bottom coal is being lost. Large companies have made a noble attempt to conserve the mineral resources of this part of the district after realizing the great value of the bed as a by-product coal.

The Pittsburgh bed averages about 5 feet 7 inches thick west of Monongahela River, and 6 feet 6 inches thick east of Monongahela River. The roof is a mixture of interbedded bands of coal and shale; the bottom is medium hard clay with local areas of hard limestone. The mines are drifts, shafts, and slopes.

Coal losses and mining methods. The main, cross, and butt entries are driven 10 feet wide. The pillar width between main and cross entries is 40 to 50 feet, side pillars are 75 to 150 feet thick, and chain pillars are 40 to 50 feet thick. The rooms are 17 to 21 feet wide, and the room pillars 17 to 25 feet wide, with the exception of the operation using the intensive system. In this system the rooms are driven on approximately 90-foot centers, 70 feet of which is pillar. The room necks are 21 feet long and 10 feet wide, and barriers are 30 to 100 feet wide. Over 50 per cent of the mining in the district between Youghiogheny and Monongahela rivers is pick. West of Monongahela River over 80 per cent is machine mining.

The greatest loss is in pulling room and entry pillars. These pillars are generally slabbed and split and large stumps are left. These stumps could be removed by pick before the break comes. In some of the smaller mines the rooms are driven too wide and the pillars too narrow, and creeps crush the coal beyond possibility of recovery. An average of 6 inches of coal is left on the bottom practically everywhere. This coal is supposed to be of slightly inferior quality, but it could be loaded and not materially lower the quality of the run-of-mine coal. The real reason for leaving it is to facilitate machine cutting. Machine men leave from 2 to 10 inches of coal on the bottom which is scrapped in but few instances. In some localities it is common practice to leave as much as 18 inches of roof coal to hold up a bad roof. This coal is supposed to be recovered when pillars are pulled, but seldom is. In some places it drops and is loaded with pillar coal, but wherever it sticks to the roof it is left intact. The

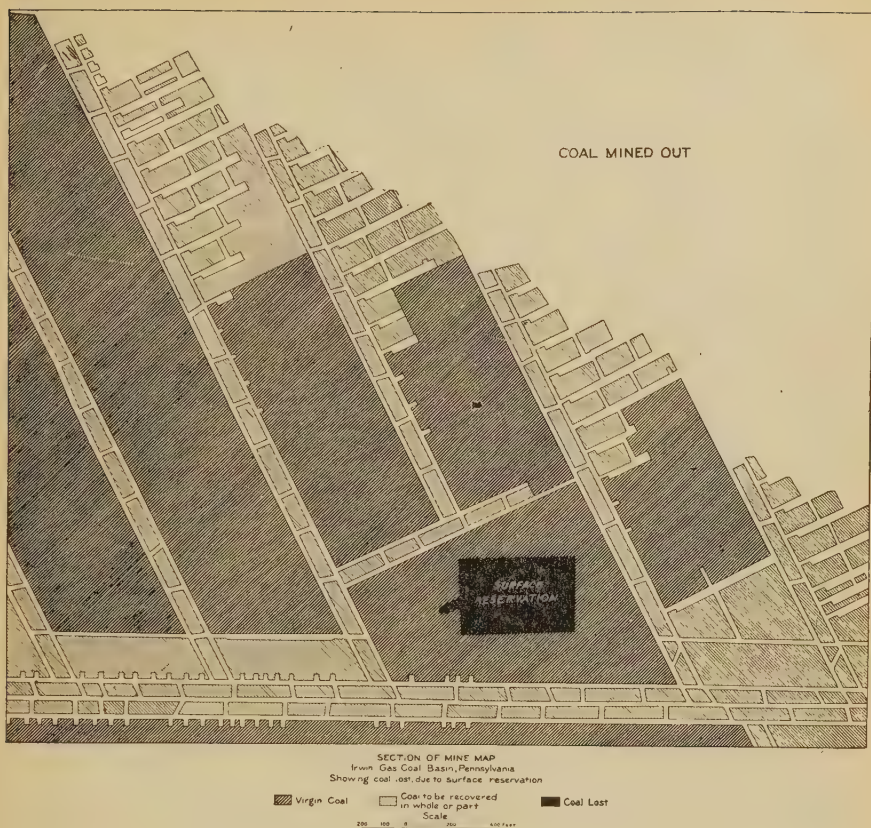


FIGURE 6.

fine coal from machine cutting is ground into the floor and is lost. In areas where the two middle binders thicken much coal clinging to them is discarded when these binders are picked out. The larger companies have tight end-gates on their cars, but the smaller ones lose much coal on the haulways. These haulways are cleaned up, but the coal is hauled outside and discarded on the dump.

As the area between the Youghiogheny and Monongahela is very thickly populated, large areas of coal under houses, streams, and railroads cannot be recovered. The barrier pillars between property lines are also extensive, but probably will be recovered in part when the properties are abandoned.

Practically no coal is lost in roll, thin and dirty areas. The Pittsburgh bed is seldom under 5 feet thick, and has good quality throughout the entire district. A rider above the Pittsburgh coal, ranging from 0 to 2 feet thick is lost when the Pittsburgh coal is mined. The commercial value of this rider coal, however, is questionable.

At the present rate of mining the Pittsburgh coal between Youghiogheny and Conemaugh rivers in the Irwin basin will last twenty or thirty years. This district contains some of the oldest mines in Westmoreland County, and has produced an enormous tonnage for many years. The mines employed the old type of mining up until the last ten or fifteen years. Large areas were worked where no pillars were pulled, and thousands of tons of good coal were left on the top and bottom. The roof in the Irwin basin is possibly easier to hold up than farther south along Youghiogheny and Monongahela rivers. The operators leave less head coal, and use more timber. The bottom is soft, however, and from 2 to 10 inches of coal is left down in order to have a hard bottom for track. This coal is slightly inferior to the main bench, being rather high in sulphur and streaked with bone. This coal could be loaded and shipped separately. Large property barriers, some of which are 300 to 400 feet thick, separate the properties in this district. These barriers will probably be recovered in part. Larger companies are planning to drain the water from old workings in order that these barrier pillars may be recovered. In the Irwin basin it is necessary to protect a great number of gas wells by reservations. The district is also densely populated and it is necessary to leave large reservations under towns, streams, and railroads. None of these pillar reservations will be recovered.

When the coal in the Irwin basin approaches exhaustion, output will decline rapidly, and be almost entirely from the removal of pillars in old workings. If these pillars were not removed the total recovery in the Irwin basin would be less than 60 per cent. However, the writer believes that with the increasing demand for producer gas, the operators in this district will find it commercially possible to recover much of the coal that has been abandoned in old workings.

The Pittsburgh coal averages 6 feet thick in the Irwin basin. The roof is a mixture of interbedded streaks of bone, coal, and shale. The roof is tender and drops readily from the sandstone above it. The bottom is a fire clay, which softens easily.

In the Irwin basin the main, cross, and butt entries are driven 10 feet wide. Pillars between the main and cross entries are 40 feet wide. The average net width of side pillars along the main entries is 75 to 100 feet. Rooms are driven 22 feet wide, and the room pillars are 24 feet wide. The room necks are 20 feet long and 10 feet wide. Barrier pillars vary greatly in thickness, ranging from 100 to 300 feet. The break-throughs are 100 feet apart, and 10 to 15 feet wide.

About 66 per cent of the mining is by machine. These machines cut anywhere from 2 to 10 inches above the bottom. In some mines

the larger companies are scrapping this bottom, but the smaller operators leave it intact, claiming that the slightly inferior quality ruins the quality of their run-of-mine shipments.

A rider coal, ranging from 0 to 3 feet 6 inches thick, and lying a few feet above the main bed, is entirely lost when the main bed is mined. This coal is generally of very poor quality, being merely a mixture of bone coal and shale. However, in a few local areas this coal could be used for steam and domestic purposes, if it were mined after the draw slate had been allowed to drop.

In order to recover a greater percentage of coal in this district the headings should be driven to the property lines, and pillars drawn on the retreat in a continuous line at a 45° angle to the haulways, providing the room pillars are thick enough. This would eliminate squeezing and reduce the length of solid roadways to be maintained.

As is characteristic of almost every district in Pennsylvania, the operators have turned off entirely too many rooms. This was done during periods of excessive demand in order to increase production. When demand slackens these rooms lie idle, the roof caves, and the timbers rot and are crushed. The coal in the pillars and breasts gradually spalls off, is crushed, and lost. These idle areas soon flood and the cost of cleaning up prohibits the recovery of the coal.

CONCLUSION

The southern part of this district is unionized. In the northern part mines are union, non-union, and open shop. The writer was unable to notice any labor difficulties that lowered the percentage of recovery of the coal. The labor force is mobile, and does not refuse to do labor of any sort, if properly paid.

The territory covered by this report is very densely populated. The mines are grouped along the rivers and railroads. Laborers, mostly foreign, are drawn from the small towns located chiefly along these streams and railroads, and mining camps are few. The water supply is chiefly from the rivers and their tributaries, and is often used without chlorination.

The houses are generally out of repair, clustered together in an unsightly manner, and the sanitary conditions are not as good as those in the Connellsville coking field.

Eight mines which fairly represent the entire district both as to production and mining conditions were inspected. An intimate study was made of each of these mines. Maps of twenty other mines were studied in the office. Areas were calculated by a planimeter and the loss checked against the production.

*Summary of coal losses in Pittsburgh gas coal district.**

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	12	6
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	1	0
	22	10

*Represents the entire district, as the Pittsburgh is practically the only bed mined.

CHAPTER VI

PITTSBURGH COKING COAL DISTRICT

LOCATION AND GEOGRAPHIC EXTENT.

Pittsburgh coking coal district is in the southwestern part of Pennsylvania, west of Chestnut Ridge, and comprises parts of Greene, Washington, Fayette, and Westmoreland counties. All of Greene County, with the exception of Richhill, Morris, Washington, Centre, and the western half of Aleppo townships, is included in this district. In Washington County, Bethlehem, Centerville Boro, southern half of East and West Pike Run, Allen, and Dunlevy townships are included. Fayette County: all townships between Monongahela and Youghiogheny rivers with the exception of the eastern third of Dunbar, the eastern half of Wharton, Stewart, and Henry Clay townships, also Lower Tyrone, Upper Tyrone, Bullskin, and Connellsville townships north of Youghiogheny River. The district also includes the following townships in Westmoreland County: southern half of South Huntingdon, East Huntingdon, Mount Pleasant, Unity, and all of Derry township except the northwestern fifth.

GEOLOGY.

Uniontown syncline and its northern extension, the Latrobe syncline, is a large structural feature forming the well-known Connellsville basin in Fayette and Westmoreland counties. The deepest part of this basin is near Uniontown where the Pittsburgh coal is 550 feet above sea-level, and 600 feet below the highest hilltops. The bottom of the basin is flat and has a maximum width of about $1\frac{1}{2}$ miles. The eastern flank is a narrow, steep slope; the western flank is wider and the slope more gradual.

The Connellsville basin has long been famous for its excellent grade of coke, which has been standard for many years. Coke was first made in this district in 1816 and 1817, according to Mr. Thomas Lynch, former president of the H. C. Frick Coke Company. "In that year Isaac Mason built the first rolling mill directly west of the Alleghenys to manufacture iron at Plumsock, Fayette County. Coke was used in the manufacture of the iron. In 1837, F. H. Oliphant made coke at his Fairchance furnace near Uniontown. The coke was made on ricks. The first oven coke was made about 1841."

According to Mr. Lynch about 800 bushels of coke were shipped by boat to Cincinnati, Ohio, in 1842. This new fuel was unknown there, and the foundrymen regarded it with suspicion, calling it cinders. It was not until the Baltimore and Ohio Railroad was completed to Pittsburgh and Uniontown, and the Connellsville coke had been successfully used in the Clinton furnace at Pittsburgh that its value as a fuel was demonstrated and the foundation laid for the demand which resulted in an unprecedented development of coke. Before 1865 the trade was small, the market being chiefly at Pittsburgh. The reputation of the coke gradually became more generally known, and the number of coke ovens increased yearly.

The coke from this region has a silvery lustre, metallic ring, is cellular, tenaceous, comparatively free from impurities, and is capable of bearing a heavy burden in the furnace. Its hardness, well developed cell structures, purity, and uniform quality have given it a great reputation as a blast furnace coke. The average yield in coke is 65 per cent.

The Monongahela group, with the valuable Pittsburgh coal at its base, underlies the entire Connellsville basin from the southern State line to Conemaugh River on the northern line of Westmoreland County. The Conemaugh and Allegheny groups outcrop on the western slope of Chestnut Ridge, and outcrop locally on the western slope of the basin; the Pottsville series outcrops only on the western slope of the basin.

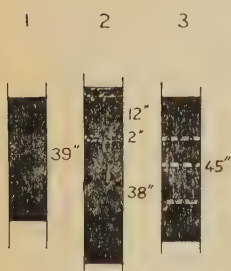
About twenty-five coal beds outcrop in this district, six of which are producing coal for shipment, a few others are mined for local farm use, and the others are too thin or too deeply buried to be commercially valuable at present. The great value of the Pittsburgh bed in this district has so overshadowed the other beds that they have not been prospected to any great extent.

The beds underlying the Pittsburgh lie deep in the basin, and the outcrops on its flanks are in a thinly populated district. The beds above the Pittsburgh, outcropping in the hilltops in the center of the basin, are more accessible and have been opened successfully during war time at different localities. Part of the future production of the Connellsville basin will come from these less important beds. The Lower Freeport coal, lying some 650 feet below the Pittsburgh, will undoubtedly be extensively tested by drill within the next few years, and probably many acres of valuable coal will be found. The Upper Freeport will probably be a coking coal with fair quality in many of these localities.

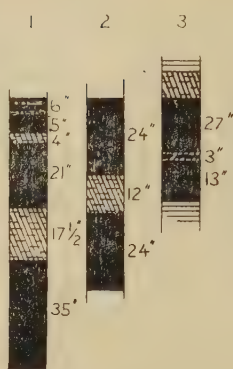
Generalized section of coal beds in the Pittsburgh Coking Coal District.

Coal bed		Average interval in feet	Average thickness
Washington	{ Washington	100	0' 10"
	{ Waynesburg "A"	60	1' 0"
Monongahela 375	{ Waynesburg	75	2' 3"
	{ Uniontown	160	1' 0"
	{ Sewickley	70	2' 0"
	{ Redstone	70	2' 5"
	{ Pittsburgh	210	9' 0"
Conemaugh 600	{ Wellersburg	235	1' 0"
	{ Hager	90	1' 8"
	{ Farmington	70	1' 8"
Allegheny 275	{ Upper Freeport	50	2' 5"
	{ Lower Freeport	50	1' 5"
	{ Upper Kittanning	70	1' 9"
	{ Middle Kittanning	25	0' 9"
	{ Lower Kittanning	80	2' 0"
	{ Brookville-Clarion	125	1' 3"
Pottsville 180	{ Mercer		1' 0"

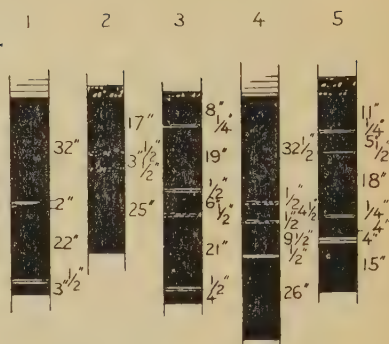
Redstone



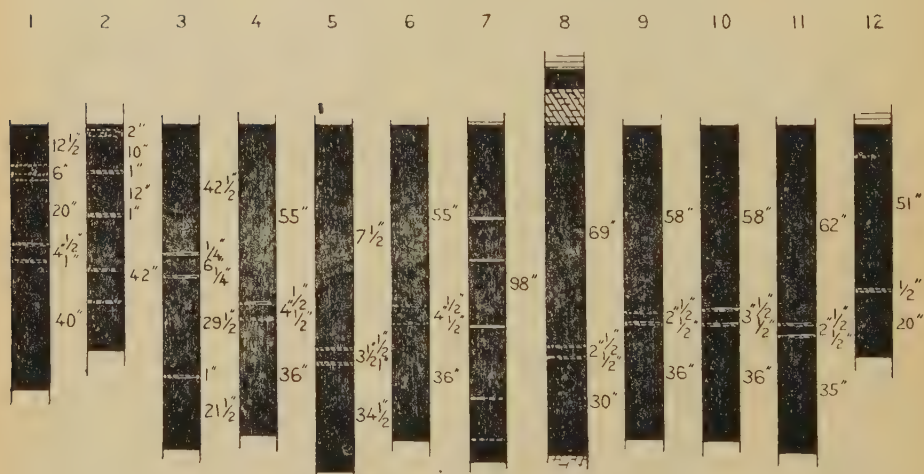
Waynesburg



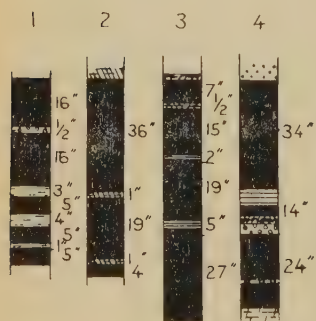
Sewickley



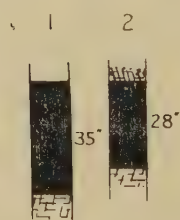
Pittsburgh



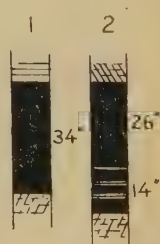
Upper Freeport



Upper Kittanning



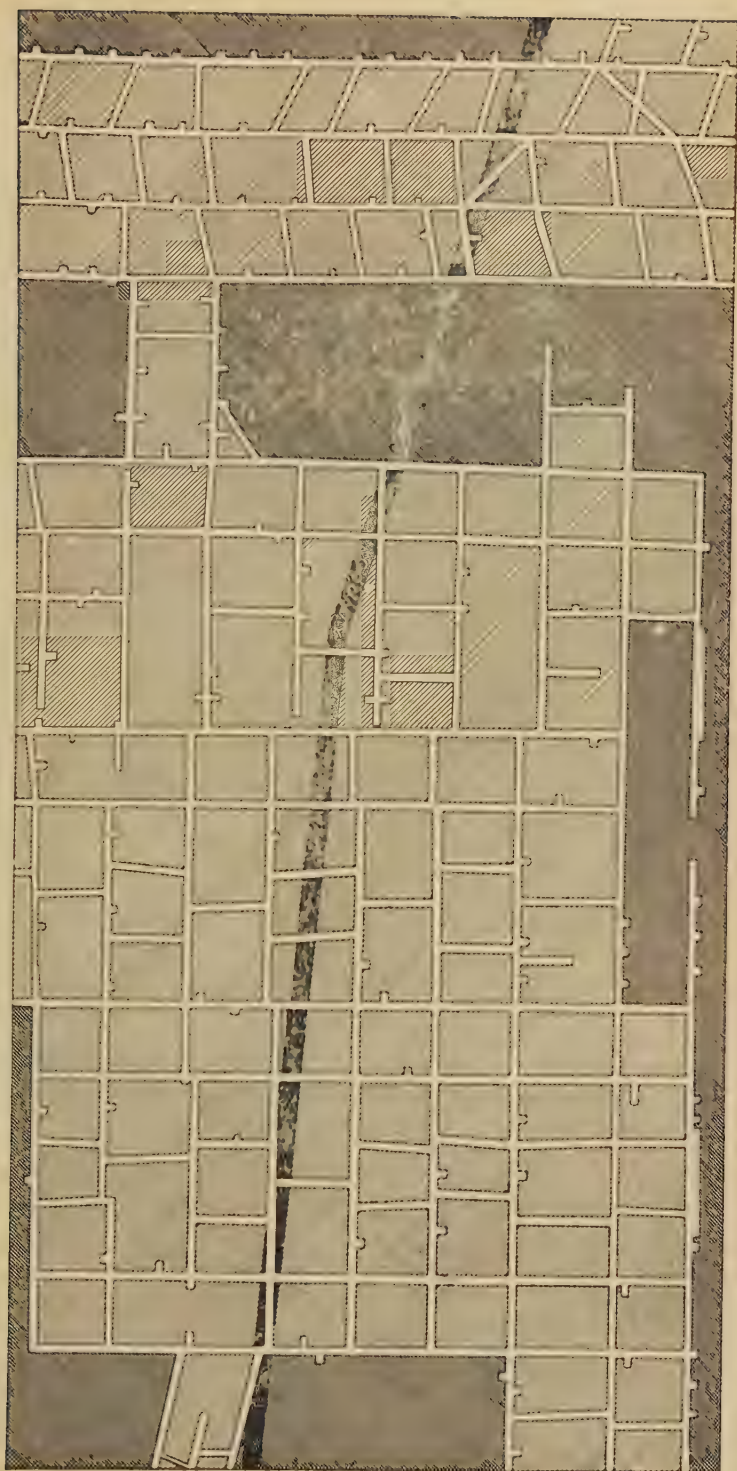
Lower Kittanning



Scale 1" = 5'

Fig. 7 Sections of coal beds in operating mines in the Pittsburgh Coking Coal District, Pa.

SECTION OF MINE MAP
Pittsburgh Coking Coal District



Virgin Coal

Coal to be recovered
in whole or part

Coal Lost

200 100 0 200 400 Feet

Scale

FIG. PL. 3.



SECTION OF MINE MAP
Connellsville Coking Coal District, Pennsylvania
Method of drawing rooms in the intensive system

Coal to be recovered
in whole or part

Virgin Coal

Scale
200 100 0 200 400 Feet

FIGURE 9.

DETAILED DISCUSSION BY BEDS.

Mercer Coal.

Along the Youghiogheny the Mercer coal is clean but varies from a few inches to 3 feet thick in short distances. On Bear Run it is 2 feet 8 inches thick; at Ohiopyle 2 feet 2 inches; at Oakland 18 inches to 2 feet thick. The bed appears to be thin but persistent on and east of Chestnut-Laurel ridge.

A coal bed 3 to 6 feet thick at the horizon of the Mercer has been noticed on Jacobs Creek but has never been mined.

Brookville-Clarion Coal.

This bed, about 30 feet above the Homewood sandstone, and called the Brookville-Clarion coal for lack of better correlation, is locally a good clean coal of mineable thickness. It changes within a few hundred feet to an impure coal, extremely high in ash and sulphur, carrying numerous clay partings which make it unmineable. Where best it is a low sulphur, low ash coal, fairly high in fixed carbon.

The bed is thickest and cleanest on the west side of the Chestnut-Laurel ridge where it was used in the furnaces in the early days of the iron ore industry in Fayette County. It was opened on Cheat River where it occurred in two benches; a top one 2 feet 6 inches thick, separated by nearly 4 feet of iron ore from a lower bench 18 inches thick. It was also mined many years ago in West Union township, and measured 8 feet 5 inches, including two clay partings, one and three inches thick. The coal had fair quality, medium in ash, fairly high in sulphur, and rather high in fixed carbon.

Lower and Upper Kittanning Coals.

The Lower Kittanning coal is deeply buried in most of the district, and little is known of its thickness and quality. Large areas remain untested, and the correlations of the beds are uncertain.

A bed is being mined in the vicinity of Dunbar where it occurs in two benches, a top one of good clean coal 2 feet 2 inches thick separated from a lower bench by a thin bone or clay parting. The lower bench is 14 inches thick; the coal is hard but has many sulphur bands. A 6-foot bed of clay directly underlying it is mined for brick making.

The coal is thin and very impure in many places, but future prospecting may discover areas where it can be mined profitably.

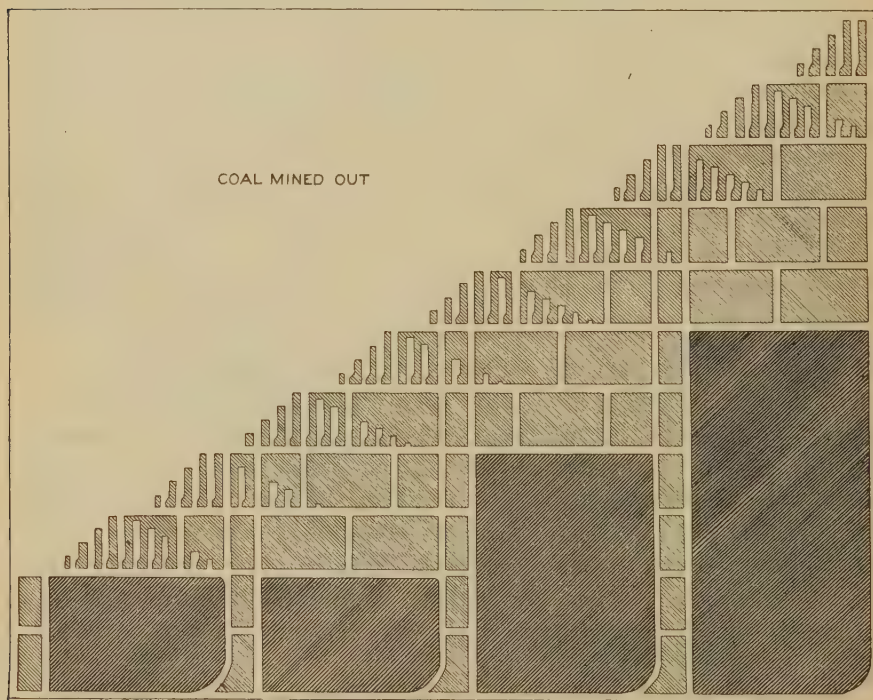
The Upper Kittanning coal outcrops along the slopes of the basin, and ranges from a few inches to 4 feet thick. Where thickest it carries several bone or shale partings which lessen its value. The Upper Kittanning is better in most places than the Lower Kittanning. The sulphur content averages less than 3 per cent, and the ash approximately 7 per cent. The fuel ratio is about 3,

Lower Freeport Coal.

The Lower Freeport is the most irregular bed in the Allegheny group in Fayette County. It is mined at Dunbar, where it averages 2 feet 6 inches thick, and carries a 2-inch bone binder about 5 inches from the top. This binder is difficult to separate from the coal. The coal is very low in sulphur but high in ash.

Upper Freeport Coal.

This bed is the most persistent of the Allegheny coals in the district. Its thickness varies from a few inches to 6 feet; it also varies from a clean coal to a coal with many partings and carrying iron pyrite. It is a well known bed on its outcrops in the eastern and central parts of Fayette county, but in the western part of the county where it is deep under cover, it is known only from drill records.



SECTION OF MINE MAP
Illustrating short wall mining in Pittsburgh Coking Coal District

Coal to be recovered
in whole or part Virgin Coal

Scale
200 100 0 200 400 Feet

FIGURE 10

The Upper Freeport coal has been opened in a great many places in the central part of Fayette county. In Springhill, Georges, Wharton, Dunbar, and North and South Union townships, the bed averages about 4 feet thick, but has several thick bone and clay partings. Locally, however, it is thinner and cleaner. At Dunbar the bed averages 4 feet 2 inches thick, but carries many partings near the top and bottom. There is 2 feet 6 inches of good clean coal in the middle of the bed. North of the Youghiogheny the bed varies from 3 to 7 feet thick, and is best at South Connellsville where it is 7 feet 2 inches thick, with only three very thin bone partings.

Drill records indicate that the Upper Freeport coal is lenticular, but is thick and excellent in some of the townships bordering the Monongahela.

This coal ranges from 1.5 to 4 per cent sulphur and from 6 to 15 per cent ash. When the Pittsburgh coal has been worked out this bed will assume importance, as it is a fair steam coal. It does not make satisfactory coke.

The Upper Freeport is the most important bed in the Allegheny group, and has mineable thickness practically everywhere in the Latrobe basin. It has been opened southeast of Mammoth, where it is 5 feet thick, including a 1-inch bone parting six inches above the bottom. It probably maintains this thickness in a large area. The Upper Freeport coal has been mined extensively for local use on the western slope of Chestnut Ridge in Unity and Derry townships. Just north of Kingston, near Loyalhanna Creek, the coal is 4 feet thick, and clean. At Youngstown the bed is 4 feet 5 inches thick, including 1 inch of clay 2 feet 10 inches from the top; on Miller Run, 4 feet 4 inches thick, including 2 inches of clay 12 inches above the bottom; one mile south of Derry 6 feet 9 inches thick, including 14 inches of shale 2 feet 4 inches above the bottom.

The coal thickens north of Loyalhanna Creek, and east of Derry measures 7 feet 2 inches, including 18 inches of shale 2 feet 6 inches from the bottom. Just east of Derry, on the summit of Chestnut Ridge, the coal is 6 feet 3 inches thick, including 3 inches of shale 4 feet from the bottom. The coal is opened at many places between Derry and the Conemaugh, and is 2 to 4 feet thick.

Conemaugh Coals.

About five coal beds, which are locally of mineable thickness, have been opened by farmers in various localities for domestic fuel. These beds will never have any great commercial importance.

Coal losses in beds beneath the Pittsburgh Coal.

All of the mines in beds underlying the Pittsburgh are small, and play a little part in the coal industry of the district. As a rule, the mining methods are inferior and no attempt is made to pull pillars. The rooms are driven wide and the pillars narrow. The headings rarely extend over a few hundred feet underground. The coal produced from these mines is used almost entirely for domestic fuel, or transported by truck to railroads during times of high prices. *The average recovery is about 60 per cent.*

Pittsburgh Coal in Greene and Washington Counties.

Distribution and character. The Pittsburgh coal outcrops along the valley of Monongahela River and its tributaries in the eastern part of Greene county. It outcrops up Muddy Creek for four miles and up Whiteley Creek for eight miles from the river. The Pittsburgh coal is probably workable everywhere in Greene County but it doubtless varies in thickness. It has good coking qualities and during recent years has been bought up by large iron and steel companies as a reserve for the future production of coke.

It is characteristically a double bed, having a roof division separated from a lower division by a clay parting from $\frac{1}{4}$ inch to 3 feet thick. In the northern part of the county especially, a roof shale 8 to 12 inches thick comes in over the upper division of the bed. The roof division of the coal varies from 2 inches to 8 feet thick and is cut by many clay partings. The coal of the roof division is very high in ash and sulphur. The lower and mineable division of the bed varies from 3 inches to 9 feet thick, including three persistent partings. These thin partings separate the lower division into four distinct benches; the upper or breast, the bearing-in, the brick, and the lower bottom. The breast coal is generally the best and thickest part of the bed and in this part of the district is free from any distinct impurities. The bearing-in bench is usually 2 to 4 inches thick with a thin bone binder above and below it, and is so soft that the miners use it to bear in on the other coal to gain a working face. The coal is soft and mines out as slack. The brick coal is so named because the cleavage planes tend to make it break and mine out in brick-shaped blocks. As a rule, the brick coal is of excellent quality although locally it is impure and not mined. The lower bottom is the lowest bench of the lower division. It is generally very impure and carries numerous shale partings. In places, however, a few inches at the top is good clean coal and is mined with the brick coal.

The roof division of the Pittsburgh bed thickens and the lower division thins northward. The characteristic binders are invariably present. In Dunkard, Monongahela, and Jefferson townships the

exposures of the Pittsburgh coal show a thin top division and a 9 foot lower division. In southern Greene County near the State line this coal measures 7 feet with $\frac{1}{2}$ inch of slate 6 inches above the bottom. On Dunkard Creek the bed is 11 feet thick with a clay parting 8 inches above the bottom. At Greensboro the roof and main clays are each 12 inches thick; the lower division of the coal is 9 feet thick with benches of 6, 1 and 2 feet. The partings are very thin. The coal appears to be thinnest at the mouth of Cheat River.

In this part of the district the roof of the Pittsburgh coal is a mixture of coal and shale which readily falls free from the sandstone above it. The bottom is fire clay of medium hardness, with local areas of limestone. A rider coal 12 to 18 inches thick, of rather impure quality, is present locally. This coal will probably have no future value.

Coal losses and mining methods. In Greene and Washington counties the entries are driven 10 feet wide. The prevailing system of mining is room and pillar. Rooms range from 15 to 24 feet wide, and room pillars from 15 to 90 feet wide. Room necks are 21 feet long and 10 feet wide. Chain pillars are 40 feet wide, and barrier pillars from 150 to 200 feet. The room break-throughs are 60 to 105 feet apart, and from 10 to 12 feet wide. Pillars are fairly well recovered in this district. The recovery of coal along the western bank of the Monongahela River has increased greatly within the last few years. When this district was opened up it was customary to leave as much as 2 feet of top coal to hold up the roof, and from 1 to 3 inches on the bottom which was slightly inferior to the excellent middle bench. When demand for coal was slight the fine sizes were discarded on the dump and only the lump coal loaded. The recovery was probably less than 50 per cent. The first mines on the west bank of the Monongahela were opened about 1875, and the coal has been shipped since that date for domestic, steam, and by-product use. At the present time the greatest loss is in pillar pulling. The pillars are slabbed and split and rather large sized stumps are left. The smaller companies sometimes leave up head coal to minimize timbering costs. Machine men cut from 2 to 5 inches above the bottom and the coal under the cut is seldom scrapped.

The loss in handling and preparation in this part of the district also is high. The larger companies use bone and shale to ballast tracks, but the smaller ones often use a mixture of coal and bone. In the vicinity of Dunkard Creek the Pittsburgh bed is inclined to be faulty, and thins very rapidly. Large areas of thin coal, which cannot be profitably removed at present, are driven around and lost entirely. This coal would have great future value after the thicker portions of the Pittsburgh bed have been exhausted. The recovery from this part of the district in Greene and Washington counties is 75 per cent.

Pittsburgh Coal in the Connellsville District between Monongahela and Youghiogheny Rivers.

Distribution and character. The Pittsburgh bed is primarily a gas coal in the river district although it is also used successfully as a steam and by-product coking coal.

The roof division is invariably present in this district, thickens to the north, and is mineable locally. It ranges from 1 to 7 feet thick and is composed of alternating layers of coal and clay.

The lower division commonly is 7 to 9 feet thick, and is always divided by thin bone partings into four benches, the breast, the bearing-in, the brick, and the lower bottom coal. The breast coal is the main part of the bed, averaging about 5 feet 6 inches thick. Bad roof conditions in places force operators to leave as much as 14 inches of this coal at the top to hold the roof. In places the brick and lower bottom coal are impure and are left as a floor. In most mines the entire lower division is mined. The lower division thins northward to the Youghiogheny.

The lower division of the Pittsburgh bed averages about 9 feet thick in German, Menallen, Redstone, and Luzerne townships; in Nicholson and Brownsville townships the average is slightly lower. In the central part of Jefferson, the western part of Perry, and the southeastern part of Washington townships it averages about 8½ feet. In the western part of Jefferson and Washington townships, and in Lower Tyrone township the average thickness is 7 feet.

The Pittsburgh coal in this district ranges from 8 to 11 feet thick. It is unusually clean, and carries but one persistent bone binder varying from ¼ to 3 inches thick, about 18 inches above the bottom. In many places several bone partings, averaging less than ¼ inch, separate the benches in the lower division. The upper division is present, but is not as characteristic of the bed as in the river district. It is left on the roof to insure safety; sometimes a few inches of top coal from the lower division is also left for safety. The floor is remarkably uniform and free from rolls.

The coal has alternating dull resinous and bright shiny streaks, and contains numerous small lenses of bone, and some pyrite; it is compact, and tends to break into cubes; is tender, and falls apart with handling. The latter character is not objectionable, as fine sizes are best for coking. The Pittsburgh coal in the Connellsville basin is also used successfully as a steam coal.

To avoid a long discussion by townships, a table showing the general average thickness of the bed in the townships included in this district, has been compiled from a great number of sections. Locally the coal may vary as much as a foot from these generalized sections, but in the main they illustrate the representative thickness of the bed.

Average thickness of Pittsburgh bed in Fayette County.

Township	Roof division		Clay		Lower division		Coal in roof division	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Springhill	4	0	0	6	8	8	1	6
Georges	4	0	2	8	9	2	1	10
North Union	2	0	0	5	8	3	0	8
Dunbar	5	1	1	0	9	0	3	7
Connellsville	5	0	1	0	8	2	3	8

North of Cheat River the bed is double, but its roof division is not mineable, being composed of alternating layers of coal and clay.

The lower division is free from impurities with the exception of small lenses of bone coal and two thin binders that occur in some places.

The chief difficulty in mining comes from a poor roof and occasional swells in the soft clay bottom.

Coal losses and mining methods. The recovery in this part of the district is better than that north of the Youghiogheny and west of the Monongahela, averaging 85 per cent. The bulk of the production from this part of the district is from the mines of the H. C. Frick Coke Company, and W. J. Rainey Coal and Coke Company, Incorporated. These companies, because of their strong financial resources, are able to employ efficient engineering methods in their mines and to conserve the coal to a greater degree than the companies operating on small capital.

These large companies drive all their headings and rooms on sights. The intensive system is used practically exclusively in this part of the district.

The main, cross, and panel entries are only 10 to 11 feet wide. The average net pillar width between main and cross entries varies from 50 to 100 feet. Side pillars also vary greatly in thickness, averaging about 70 feet in the Uniontown district. Rooms, which are driven in 80 to 120 foot panels, range from 12 to 14 feet wide, with room pillars 70 to 80 feet wide. Barrier pillars range from 50 to 200 feet wide. The pillars are split and drawn back on the retreat at an angle of about 45° to the haulways. Very little coal is lost at the present time in pillars. Some few stumps and small parts of the pillars are left when they are slabbed.

The greatest loss of coal in this part of the district is on the top and bottom. Most mines leave up from 2 to 18 inches of top coal to prevent the roof from air-slaking, and to minimize timbering costs. The operators claim that this coal in some mines is too high in phosphorous to make good coke. Much of this loss could be prevented by carefully removing this roof coal in the rooms and head-

ings when the pillars are drawn. Should this coal be too high in phosphorous to make standard coke, it could be loaded separately and used as a steam and domestic fuel.

The bottom of the Pittsburgh bed is roly in some parts of the district, and machine men leave from 2 to 10 inches of coal on the bottom. In some mines this coal is taken up, but it is not a prevalent practice. Much coal is lost in handling and preparation. When the coal is shot off the solid the charges are so heavy that a great deal of fine coal is blown onto the gobs and roadways. This coal is not recovered. The room floors are not cleaned as well as they might be before the roof is allowed to break and cave. Some of the smaller companies use coal for ballasting tracks. In certain localities where the partings thicken and must be separated from the coal, much coal is discarded with these bands on the gob. The quantity of coal lost in reservations is large in this district because it is thickly populated, many railroads run over the mines, and the region has many water courses.

In the district bordering Monongahela River particularly, large barrier pillars must be left around oil and gas wells and between adjoining properties. The writer believes, however, that fully 75 per cent of the coal in these property barriers will be recovered when the mines are abandoned.

The mines have not been bothered with creeps and squeezes after the installation of the intensive system in which the rooms are driven on 90 and 100 foot centers. Some small creeps and squeezes have been induced by driving too many rooms when excessive production is desired, and allowing these rooms to stand idle when demand is slack. Several mines have worked panels during excessive demand and later allowed them to stand idle. The roof has caved and large areas have flooded, making the cost of recovering the coal prohibitive; consequently the coal has been abandoned. Very little coal is lost in roly, thin, or dirty areas. The Pittsburgh bed is very persistent in thickness and remarkably free from clay veins and sandstone "faults" in this district. Locally the partings between the benches of coal thicken but not enough to warrant discarding any large areas.

Pittsburgh Coal between Youghiogheny and Conemaugh Rivers.

Distribution and character. In the Latrobe basin, which includes the northern end of the Connellsville coking coal field, the Pittsburgh coal has the same coking quality as at Connellsville, except in the area northeast of Latrobe.

The Pittsburgh coal in the Latrobe basin consists of a roof division, a main clay parting, and a main division. The roof division is worthless, being composed of a number of alternating bands of coal and clay.

The main division consists of an upper bench, the breast coal, 3 to 4 feet thick; underlying this is a small bench, from 2 to 4 inches thick, separated from the coal above and below by knife blades of bone. This bearing-in bench is underlain by a bench 17 inches thick, which, from its blocky character, is generally known as the brick coal. An impure bottom bench 12 to 18 inches thick is separated from the brick coal by a thin bone parting. This bench is generally so impure that it is not mined.

The Pittsburgh coal is 5 to 6 feet thick at Millwood, and has the characteristic impurities; near Blairsville it is 6 feet thick, including $1\frac{1}{2}$ inches of bone two feet from the bottom. On Union Run it is 7 feet 6 inches thick, including 14 inches of partings; at Beatty, 7 feet 11 inches thick, including two 1-inch partings. Here the lower bench is very dirty. The coal has the same characteristics at Whitney, Hostetter, and Baggaley. At Klondike it is 7 feet 9 inches thick, including two 1-inch clay partings. At Mammoth the Pittsburgh coal is mined by shaft 110 feet deep, and is 6 feet 6 inches thick, including a $\frac{1}{2}$ inch bone parting three feet from the top.

Coal losses and mining methods. The recovery in the Pittsburgh bed between Youghiogheny and Conemaugh rivers is 80 per cent. The greatest loss is in room, entry, and panel pillars. These pillars are often squeezed and crushed and can be recovered only in part; when pulled rather large stumps are left. These stumps could be removed by pick. The main, cross, and panel entries are driven 9 to 10 feet wide. Pillars between main entries are from 60 to 70 feet wide; between cross entries, 40 to 60 feet wide. Side pillars are usually 60 to 100 feet wide. Rooms are generally driven on 65 foot centers, 40 feet of which is left as pillar. Many companies also use a 45 foot center with a 30 foot pillar. The room necks are generally 20 feet long and 6 to 8 feet wide. The break-throughs are 90 feet apart and 8 to 10 feet wide. A large quantity of coal is also lost in this part of the district by leaving from 6 to 16 inches on the top to hold up the roof, and 2 to 4 inches on the bottom after machine cutting. The top coal could be recovered when pillars are drawn, but generally is not. The bottom coal is recovered in very few mines. This bottom coal is possibly of slightly inferior quality, but would not materially reduce the general quality of the run-of-mine shipments. In mines producing coal for coke the top and bottom coal could be loaded separately and used for steam and domestic purposes.

The mines in this part of the district are not as well managed as those in the vicinity of Connellsville and Uniontown, and the engineering methods are mediocre. The larger companies employ efficient engineers and run their rooms and headings on sights.

The smaller companies have driven in their headings and turned off their rooms in a haphazard manner, in order to recover the most coal in the least time at the lowest cost. In these smaller mines the loss in handling and preparation is excessive. The pillars are too thin to withstand the crushing weight of heavy cover, and large areas are lost in creeps. Too many rooms are turned off the butt headings in order to increase tonnage, and are allowed to stand and cave when demand is slack. Operating companies not having enough capital to clean up rooms and put them into producing shape abandon them and the coal is lost.

Coal losses in Pittsburgh bed.

	Total	Avoidable
On roof and bottom	3	3
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	1	0
	16	7

Redstone Coal.

Distribution and character. This bed, which lies 50 feet above the Pittsburgh coal, is persistent in Greene County but rarely is mineable, its average thickness being less than 18 inches. Its horizon is often marked by black shale and a few inches of coal. Along Monongahela River the bed is represented by 13 feet of bituminous shale; in the districts back from the river the bed is a few inches of clean coal.

The Redstone coal is persistent in the river district of Fayette County, but averages less than 2 feet. Where the bed thickens, partings of shale and bone make mining unprofitable except for house coal.

At Lemont air shaft the coal is 4 feet thick; at Hill Farm 3 feet, and at Leith shaft 5 feet 7 inches. It carries several very thin bone partings that lessen its value. South and southwest of Uniontown the bed has been opened for domestic use and averages about 3 feet thick. Many thin lenses of bone and knife blades of pyrite make its ash and sulphur rather high. In Springhill township the bed averages $4\frac{1}{2}$ feet thick and is mined for house coal. It has poor quality, and will probably never be valuable as a shipping coal.

Coal losses and mining methods. The Redstone coal is mined in a few localities by farmers for local use. Only a few mines are producing coal for shipment. These mines were opened within the last few years and practically no pillars have been pulled. The oper-

ating companies are small and little attention is paid to mining methods. The chief aim is to obtain large production at minimum cost. The recovery in this bed is probably about 60 per cent.

The great loss is in the pillars, which are too narrow, and although the overburden is quite thin in most places, are already being squeezed. In these mines many rooms have been turned off of each heading, the easily mineable coal taken out, and the rest abandoned. The bed is thin and subject to great irregularities in thickness. Large areas have been abandoned because of prohibitive production costs. In mines not having natural drainage, large areas have been lost by flooding when the mines are idle.

The Redstone coal lies from 50 to 70 feet above the Pittsburgh, and has been ruined in large areas by the Pittsburgh coal being mined out beneath it. The roof and bottom are fractured and the coal crushed. Companies operating where the Pittsburgh coal has already been mined find that in large areas it is impossible to timber the roof safely enough for miners to work.

Sewickley Coal.

Distribution and character. The few outcrops of the Sewickley in Greene County are confined to the eastern part where it is mined chiefly in the vicinity of Mapletown, hence its local name, the Mapletown coal. Here the coal varies from 4 inches to 5 feet 6 inches. At Grays Landing the bed is in two 2-foot benches separated by 1 foot of shale. At Hartley's Mills the coal is thicker than at Gray's Landing, but much parted by clay. The top and middle benches are fair coal, but the lower bench is dirty and carries much sulphur. Below Clarksville on Tenmile Creek the coal is 12 to 20 inches thick and carries one to three partings. The coal is thickest at Mapletown, where it is divided into three benches of 2 feet 3 inches, 4 inches, and 2 feet 6 inches, parted by clay binders 1 to 2 feet thick. It lies about 120 feet above the Pittsburgh coal.

A coal 120 to 175 feet above the Pittsburgh bed, is opened at many places in Fayette County both for domestic and shipping coal. This bed varies from a few inches to 6 feet. It is very dirty and impure, but locally where thick, has excellent quality and commercial mines have been opened in it. The bed is variable in its physical and chemical qualities. It averages about $3\frac{1}{2}$ per cent sulphur, and its ash is about 11 per cent. The volatile matter is very high. Washing and picking make it an excellent steam coal.

In the vicinity of Masontown the Sewickley coal has a maximum thickness of 6 feet, and averages 5 feet 10 inches. A few inches at the top of the bed is a mixture of pyrite bands and coal, but the remainder is clean. At Fairchance the bed averages 4 feet 2 inches thick, with five inches of bone at the top, a $\frac{1}{4}$ inch binder 3 feet from

the roof, and a $\frac{1}{2}$ inch parting near the bottom. At Uledi it averages 4 feet 6 inches thick, with a $\frac{3}{4}$ inch bone binder 2 feet from the bottom. Rolls in the clay floor make mining difficult. The coal is mined at many other places in Fayette County, but variations in thickness and quality in a short distance make successful mining uncertain.

The roof of the Sewickley coal is generally shale and soft sandstone; the bottom is medium hard clay, and locally, shale.

Coal losses and mining methods. The main, cross and butt entries are 10 feet wide. Forty-five to 50 feet of pillar is left between both main and cross entries. The side pillars are usually about 100 feet wide. The room necks are 20 feet long and 8 feet wide. Rooms range from 12 to 18 feet wide, and room pillars from 20 to 25 feet wide. Barrier pillars are generally 100 feet wide. All mines in the Sewickley coal are small, producing coal chiefly for steam purposes, and for the Lake trade.

The mining conditions in the Sewickley are much better than those in the Redstone. Some of the small mines run their rooms and headings on sights, and are pulling pillars with considerable success. The greatest loss is in the room pillars; they are slabbed and split, and rather large stumps are often caught by the break before they are removed. The rooms are not properly cleaned before the break covers the coal which is strewn over the floor. In mines where solid shooting is practiced, considerable quantities of coal are blown onto the gob. This coal, of course, is not recovered. The cars usually do not have tight end-gates, and much fine coal is tramped into the bottom along the haulways.

The Sewickley coal is often much affected by undermining of the Pittsburgh bed. The roof is fractured and the bottom heaved. However, the coal does not seem to have been subjected to extra pressure and is not crushed or cracked. Excessive timbering costs in localities where these conditions are present often prevent operators from recovering coal which under normal conditions could be extracted at market price. These areas, of course, are necessarily abandoned and the coal is lost. This factor reduces the percentage of recovery in the Sewickley bed fully 5 per cent.

Coal losses in Sewickley bed.

	Total	Avoidable
On roof and bottom	2	1
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	3	1
	22	10

Waynesburg Coal.

Distribution and character. This is the most important bed above the Pittsburgh coal in Greene County. It is the main source of domestic fuel in many localities, yet the quantity mined is small in comparison with the output of Pittsburgh coal. Its position, 400 feet above the Pittsburgh coal, makes the outcrop more general and accessible locally. It extends up South Fork of Tenmile Creek toward Waynesburg, along Whiteley Creek and Dunkard Creeks and Meadow Run. In the eastern part of Washington County the Waynesburg coal is 5 to 9 feet thick. In most localities it is a double bed. The upper bench varies from 1 to 3 feet and the lower bench is from 2 feet 6 inches to 4 feet thick. The benches are separated by a clay and shale parting having a thickness of 3 inches to 2 feet 4 inches. The coal is hard, but contains a large percentage of ash and sulphur. On Tenmile Creek the bed is 4 feet 11 inches thick, 17 inches of which is clay. At Jefferson it has a thickness of 7 feet 8 inches, with two clay partings totaling 18 inches thick. At Clarks-ville it is 6 feet 4 inches thick, with two clay partings of 5 and 14 inches. On Big Whiteley Creek the bed is 4 feet 11 inches thick and carries two 2-inch clay partings.

The Waynesburg bed is unimportant in the Uniontown-Connells-ville district, and has been opened in only a few places. It is mined in Dunbar township, where its maximum thickness is 3 feet 4 inches. A 3-inch bone binder, 13 inches from the bottom, cuts the bed into two benches. The coal is extremely high in ash, and rather high in sulphur.

The Waynesburg coal has been mined more extensively in the river district, but it is not persistent. On Redstone Creek the bed is locally 10 feet thick but is composed of alternating bands of coal and clay. Where the bed is thinner the quality is better, and the coal is used for domestic fuel. On Dunlap Creek the bed is very impure. In the vicinity of Heistersburg and Merrittstown it averages 5 feet thick, and occurs in several benches, one of which is often clean enough to be mined. On Wallace Run the bed is 4 feet 5 inches thick, with a few inches of bone coal 12 inches from the roof. North of Masontown it is split by three clay partings, and is 7 feet 2 inches thick.

The roof of the Waynesburg coal is sandstone and shale, generally fairly good. The bottom is invariably soft clay.

Coal losses and mining methods. The Waynesburg coal is mined entirely by drift. The entries are driven 12 feet wide; the side pillars are 75 feet wide. Rooms are generally driven on 40 foot centers, 22 feet of which is pillar. Barrier pillars are 75 feet wide.

All mines in this bed are small, shipping coal chiefly in time of high prices. The coal is used for steam and domestic purposes in the vicinity of Pittsburgh, and for local trade.

The greatest loss in this bed is due to its dirty, faulty condition. Coal is left both on the top and bottom where binders thicken, preventing the removal of this coal at a profit. Much coal sticks to these binders and is discarded on the gob. The coal thins rapidly in places, and is lost under faults. Where machines are used, several inches are also lost on the bottom. The loss in handling and preparation is also large, due mainly to leaving coal scattered in the headings and rooms. Pillars are pulled fairly well, but many are left because of small size and the presence of impurities.

The area of the Waynesburg coal is limited and the production will be small. The average loss of the entire district is not much influenced by the mining conditions in this bed.

Coal losses in Waynesburg bed

	Total	Avoidable
On roof and bottom	10	6
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	0	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	2
	31	16

CONCLUSION.

The living conditions in this district are probably the best for mining towns. The district is thickly populated and medium-sized towns supply a large percentage of the labor. In isolated districts the larger companies have established mining communities and camps, and have generously looked after the welfare of their employees. The houses are modern, and in many instances are equipped with modern plumbing, and with an ample supply of good water. These companies promote community spirit by offering prizes for the best kept lawns and for the best gardens in each community. The houses are painted both inside and out every few years, and are kept in good repair. Churches and schoolhouses have been built, offering excellent opportunities for the mental and moral development of the miner and his children.

Practically all the mines in this district are operated on the open shop basis, and there are no labor difficulties which lower the percentage of recovery of coal.

Two mines representing the best and worst in the district were inspected. Maps of thirty other mines were studied in the office.

Summary of coal losses in Pittsburgh Coking Coal District.

	Total	Avoidable
On roof and bottom	3	3
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	1	0
	18	9

CHAPTER VII

BEAVER-MERCER DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Beaver-Mercer district, lying in the western part of Pennsylvania and bordering on Ohio, includes Beaver, Lawrence, and Mercer counties, and all but the eastern sixth of Butler County.

GEOLOGY.

Coal was first mined in this district about 1875. The principal production was in Mercer and Lawrence counties from a bed in the Pottsville series known as the Sharon block coal. The coal has been long exhausted, and mining is now confined to coals in the Allegheny group.

Fourteen coal beds outcrop in this district, five of which produce coal for commercial use, three others are mined for local domestic purposes, and the others are exhausted or too thin and dirty to have commercial value.

Generalized section of coal beds in Beaver-Mercer District.

	Bed	Range in interval	Range in thickness
Conemaugh	Bakerstown		0 — 3' 0"
	125		
	Mahoning	40-55	6" — 2' 6"
Allegheny	Upper Freeport ("E")	50-65	6" — 9' 6"
	Lower Freeport ("D")	40-80	0 — 3' 0"
	Upper Kittanning ("C'")	40-55	0 — 4' 6"
	Middle Kittanning ("C")	40-70	0 — 4' 6"
	Lower Kittanning ("B")	40-60	0 — 3' 6"
	Scrubgrass	20-30	1' — 1' 6"
	Clarion ("A'")	20-35	0 — 7' 0"
	Brookville ("A")		1' — 4' 6"
	Homewood	15-20	
Pottsville	Upper Mercer	30-40	0 — 3' 0"
	Lower Mercer	60-80	0 — 4' 0"
	Quakertown	80-100	0 — 3' 0"
	Sharon		0 — 5' 0"

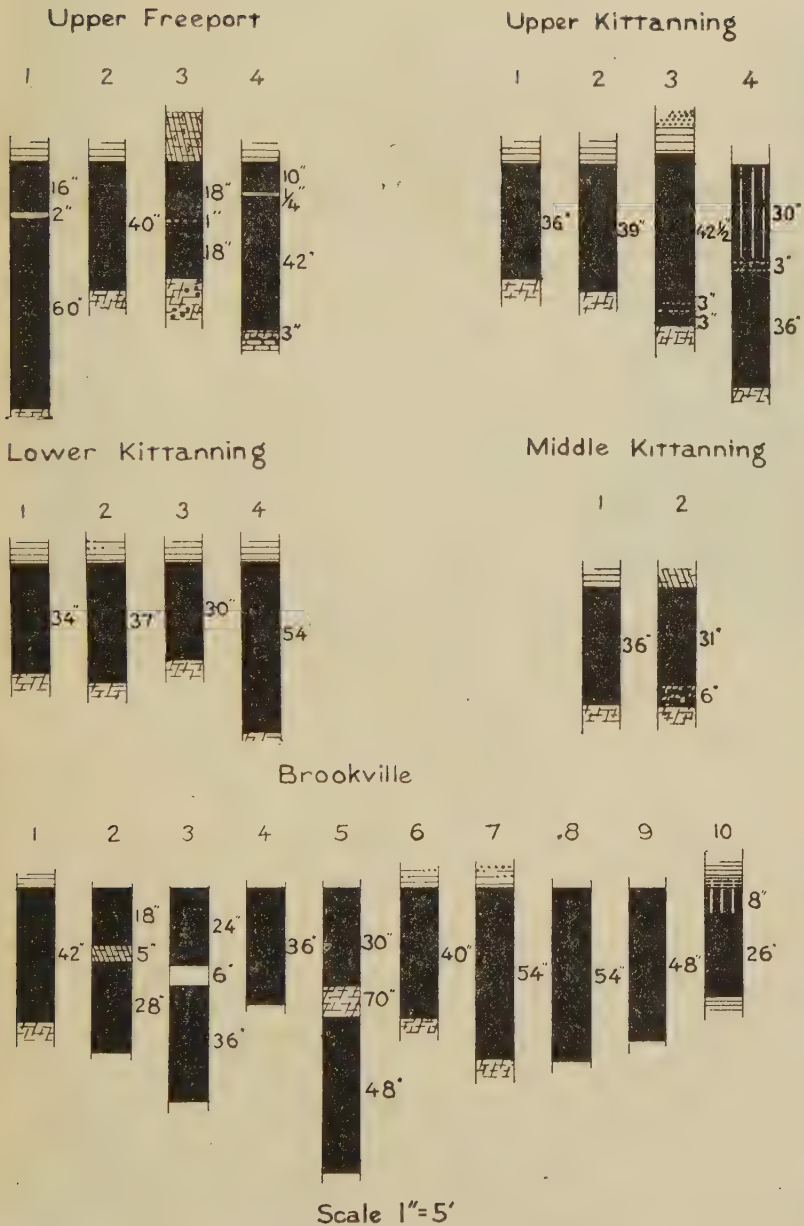
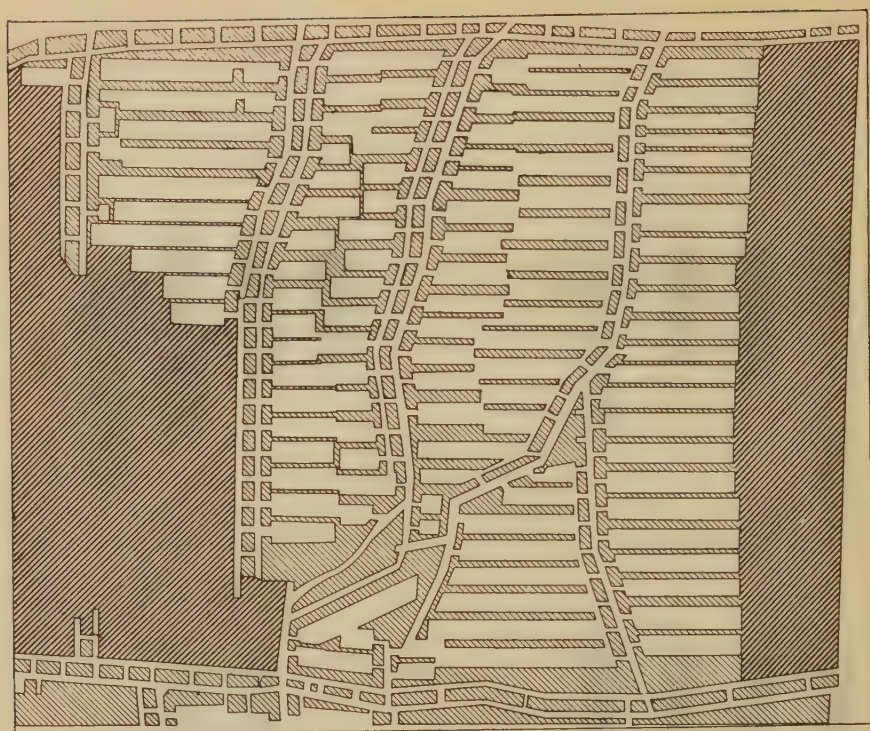


Fig. II Sections of coal beds in operating mines in the Beaver-Mercer District, Pa.



SECTION OF MINE MAP
Beaver-Mercer District

Virgin Coal

Coal to be recovered
in whole or part

Coal extracted

Scale

100 50 0 100 200 Feet

Figure 12

DETAILED DISCUSSION BY BEDS.

Pottsville Coals.

Distribution and character. The Pottsville coals are geologically the lowest bituminous beds that have been mined in Pennsylvania. The Sharon coal was mined and practically exhausted more than 50 years ago. Many thousand tons were mined from this bed in isolated areas in the western part of Mercer County for use as steam and domestic fuel, and in blast furnaces. The coal was low in sulphur, very high in moisture, and variable in ash. Locally the fixed carbon was very high, with a correspondingly low percentage of volatile matter. The coal was hard, bright, and mined out in good sized lumps. It disintegrated very fast on exposure and was not suitable for storage.

The bed ranged from a few inches to 5 feet thick, and averaged about 4 feet. It was generally very clean, with no distinct binders or partings. Locally the coal was so poor that it could be classed as a bituminous shale.

The writer was unable, of course, to inspect any of the openings in this bed, but conversation with some of the older inhabitants suggests that this coal was mined very carefully. Its value in the blast furnaces and as a domestic fuel in this outlying district was greatly appreciated.

The Quakertown, Lower Mercer and Upper Mercer coals in the Pottsville series, are thin and unimportant and are valued only as a source of domestic fuel. Their thickness is very irregular and the quality variable.

Brookville ("A") Coal.

Distribution and character. The Brookville coal, lying at the base of the Allegheny group, is the most important coal in Mercer County, where it is known as the "Pardoe" bed. All the large mines are working this coal and practically the entire output of the county comes from it. The bed ranges from 3 feet 6 inches to 4 feet thick, and is free from any noticeable impurities, with the exception of a pyrite band of one inch or less, generally from 4 to 10 inches from the top. Locally other binders develop and a few inches of draw slate occurs at the top.

The Brookville is mined extensively at Hilliards and Argentine in the northern part of Butler County. It is 3 feet 8 inches thick at Argentine, including a 1-inch bone parting 9 inches from the top. At Erico Station the bed varies from 3 feet 10 inches to 4 feet 4 inches thick, and has a 1-inch parting 9 inches from the top. At Goff Station the bed is 4 feet 6 inches thick, including the characteristic bone parting; at Hilliards, 3 feet 4 inches to 3 feet 8 inches thick, including one parting.

The Brookville coal has a limited outcrop in the southern part of the district, and is being mined at very few places. At the mouth of Brady Run, it is 2 feet 9 inches thick, 6 inches of which is clean coal. Along Beaver River the bed is in two benches, 7 and 14 inches thick, separated by 3 feet of shale. In other parts of Beaver County the coal is either below drainage or covered by glacial drift. The cover ranges from crop to 900 feet. The immediate roof is medium hard shale; the bottom, medium shale and fire clay.

Coal losses and mining methods. All mines in the Brookville bed are drift. The system of mining is room and pillar. The average net width of main, cross, and butt entries is 10 feet. The average net pillar width between main and cross entries is 45 feet. Side pillars

are 35 feet wide. The room necks are 40 feet long, and 10 feet wide. Rooms are driven on either 48 or 63 foot centers, with pillars 18 feet wide. The recovery in this bed is fairly good in Mercer County, averaging about 70 per cent, but in the remainder of the district a large quantity of coal is lost in room pillars, and in some mines no attempt is made to pull any pillars. The cover in the northern part of the district is very thin, enabling the operators to drive rooms wide, leaving thin pillars. This system of mining often induces creep in the roof, which crushes the coal and timbering, making impossible the recovery of large areas of standing pillars.

The Brookville contains many local areas of dirty coal which may not be merchantable at present, but might be in the future. However, their ultimate recovery is made impossible by the present method of mining around them.

Much coal is lost in handling and preparation. The miners pick coal carelessly, discharging large amounts on the gob. Machine men leave 2 or 3 inches of coal on the bottom which the miners do not attempt to remove.

Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	22	13
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	6	3
	37	20

Lower Kittanning ("B") Coal.

Distribution and character. The Lower Kittanning coal, lying from 90 to 115 feet above the Brookville, has been eroded in practically all the northern part of this district. It is very thin in Butler County, and is mined in Summit, Brady, and Slippery Rock townships, where it averages 2 feet 8 inches thick. The main production is from southern Lawrence and Beaver counties. The bed ranges from 14 inches to 2 feet 11 inches thick, averaging about 2 feet. It is lenticular, and high in sulphur, particularly so east of Beaver River, where it is known as the "sulphur vein". An underlying bed of excellent fire clay adds much commercial importance to the coal.

The Lower Kittanning is 2 feet 6 inches thick on the North Branch of Brady Run, and has excellent quality. It has been used for blacksmithing purposes. On Blockhouse Run the coal is 18 inches thick, and high in sulphur. South of Phillis Island the bed is 2 feet 11 inches thick, including 2 inches of shale 6 inches above the bottom. At Monaca the bed is 2 feet thick, but the upper half is very bony.

The cover ranges from crop to 800 feet. The immediate roof is medium hard shale; the bottom shale and fire clay.

Coal losses and mining methods. This bed is mined entirely by drift on the room and pillar system. The principal loss is in room, entry, and panel pillars. An attempt has been made to remove these pillars while mining the clay, but in many mines this plan was abandoned because of excessive timbering costs. Where the clay is high in iron and not merchantable, the coal is not mined. Much coal is also lost in handling and preparation. The average net width of main, cross, and butt entries is 100 feet. The pillar width between main and cross entries is 30 feet. Side pillars average 35 feet wide. The room necks are 25 feet long, and 10 feet wide. Rooms range from 25 to 35 feet wide, and room pillars from 15 to 22 feet wide.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	25	13
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground surface	4	2
In roly, thin or dirty areas	4	2
	38	19

Middle Kittanning ("C") Coal.

Distribution and character. The Middle Kittanning coal, lying from 40 to 70 feet above the Lower Kittanning, is mined only in Beaver County. This bed, although laterally persistent, is exceedingly variable in thickness, ranging from 12 inches to 3 feet 8 inches. In the area along Ohio River west of Dam No. 6 the bed is usually between 14 inches and 2 feet 2 inches thick, free from partings, and apparently improving in quality and thickness westward. On both sides of the river, in the vicinity of Georgetown, it is 2 feet 6 inches thick, and is an excellent block coal. It has been opened for local use.

The Middle Kittanning is only 4 inches thick at Vanport; but 2 feet 6 inches to 3 feet thick at the mouth of Mill Creek. On the North Branch of Brady Run it is 16 inches thick, including 6 inches of shale 3 inches above the bottom; south of St. Clair the bed ranges from 14 to 20 inches thick.

East of Beaver and Ohio rivers the coal is generally uniform in thickness, of fair quality, and free from partings. It ranges from 14 to 20 inches thick.

The Middle Kittanning coal has been eroded in practically all the central and northern parts of the district. Its value is only for local farm use.

The cover ranges from crop to 725 feet. The immediate roof is hard shale; the bottom, soft fire clay.

Coal losses and mining methods. The Middle Kittanning coal is mined entirely by drift, on the room and pillar method. The net width of entries is 10 feet; chain pillars, 40 feet. The rooms are driven on 35 foot centers, 15 feet of which is pillar. The mines in this bed are all small and run only part of the year. Pillar pulling is practiced without very much success because timbers rot and creeps and heaves destroy the coal during idle times. Practically no machines work in this bed, the loss from roof and bottom coal being due to 1 or 2 inches which does not break free from the roof and is left up by the miners. Much coal is lost in handling and preparation and in roly, thin and dirty areas.

Coal losses in Middle Kittanning bed.

	Total	Avoidable
On roof and bottom	2	1
In room, entry, and panel pillars	25	15
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	2
	38	20

Upper Kittanning ("C") Coal.

Distribution and character. This coal, lying from 40 to 45 feet above the Middle Kittanning, has been eroded in practically all the northern and central parts of the district. It is generally thin in Butler and Lawrence counties, and is mined in few places. In Center township, Butler County, it averages 4 feet thick, including many numerous shale and bone partings.

The Upper Kittanning is also thin and unimportant in Beaver County, seldom being over 6 or 8 inches thick. On Brush Run, however a coal, possibly the Upper Kittanning, has been mined locally, and is reported 4 feet thick.

The Upper Kittanning is locally a cannel coal in Beaver County. At Cannelton the bed is almost entirely cannel coal, having a maximum thickness of 13 feet, and averaging 7 to 8 feet. It fills an old channel shaped like a hook or ox-bow. The channel is 300 to 600 feet wide and nearly 3½ miles long. The cannel rests on bituminous coal ranging from 1 inch to 2 feet thick. The roof is shale of medium hardness; the bottom is also shale, but is soft.

Coal losses and mining methods. The mines in this bed are small drifts, and worked intermittently. The greatest loss is in room, entry, and pannel pillars. Pillar pulling has been attempted and about half of the room pillars recovered. The barrier and chain pillars are also recovered when the mines are abandoned. A very large percentage of loss is in handling and preparation. These

mines are generally so small they do not come under the mine inspection law of Pennsylvania, and operators pile coal along the roadways and neglect to clean up the room floors before the roof caves. The bed is extremely variable in thickness; rolls on the top and bottom are frequent. Much coal is lost in areas where the coal is thin or slightly inferior in quality.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	25	15
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	5	3
In roly, thin or dirty areas	5	2
	40	22

Upper Freeport ("E") Coal.

Distribution and character. The Upper Freeport coal, lying from 105 to 130 feet above the Upper Kittanning, is the most important coal in Beaver and Lawrence counties. It has been entirely eroded in Mercer County, and only a few isolated areas remain in northern Lawrence and Butler counties. The bed is persistent in Beaver and Lawrence counties, and ranges from 6 inches to 5 feet thick. Where thickest it has 6 to 8 inches of impure, shaly top coal, and the main bench of good coal is 2 feet 5 inches to 3 feet thick. In the northern part of Beaver County, where not removed by erosion, it is 4 to 5 feet thick. The Upper Freeport has been mined extensively in the western part of the county and shipped as a gas coal. It has a persistent thickness of 4 feet 6 inches, and is divided into four benches by thin shale partings. The bottom and top benches are impure and worthless. The main bench is good coal, averaging 3 feet thick. The areas of thick coal in this vicinity are small, and the coal is high in sulphur. The thickness diminishes northward, but the coal is purer. East of Beaver and north of Ohio rivers the bed averages 17 inches thick, and is separated by many bone partings.

South of Ohio River and east of Raccoon Creek the coal is locally fairly thick, but is much parted by bone and shale. South of the Ohio and west of Raccoon Creek the bed ranges from 16 inches to nearly 7 feet thick. It carries several bone partings, but the benches are thicker than in the region north, and tend to overcome this disadvantage. On Squirrel, Fish Pot, and Island runs, and Service Creek, the coal is separated by partings thick enough to make it a split bed. The immediate roof is hard shale and sandstone; the bottom, fire clay and shale. The cover ranges from crop to 525 feet.

Coal losses and mining methods. The Upper Freeport is mined entirely by drift in this district. The net width of main entries is 12 feet; the chain pillars are 60 feet wide. Rooms are driven on 46 foot centers, 20 feet of which is pillar work.

Pillars are being drawn with more success in this bed than any other in the district. However, the operators are not consistent and lose fully 5 per cent in handling and preparation, chiefly underground. All the mines are small and the majority do not come under the mine inspection law. Operators take advantage of this and pile coal and bone along the roadways, and make no attempt to reload and save this coal. A large quantity of coal sticking to the binders is also discarded by the miners.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	5	5
In room, entry, and panel pillars	15	10
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	5	3
In roly, thin or dirty areas	4	2
	31	20

CONCLUSION.

The writer saw no loss of coal due to the mining of underlying beds. The district is not developed to any great extent, and no two beds are being mined or have been mined in close vertical proximity. Unless pillars are pulled in a proper systematic manner in present day mining there will be a great future loss in beds overlying the ones now being worked.

Practically all the mines in this district are non-union. The laborers in the mines do not refuse to do certain duties which would decrease the percentage of extraction. A fixed scale is paid on yardage. The mining centers of this district are either in or close to thickly populated regions. Conditions are therefore better than many other districts in the State. The labor force is mobile and is drawn largely from nearby towns.

The conclusions drawn herein are based upon personal inspection of fifteen representative mines. Data and maps of forty-three others were studied in the office.

Summary of coal losses in Beaver-Mercer District.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	22	13
In oil and gas well pillars	1	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	2
	36	19

CHAPTER VIII

ALLEGHENY-CLARION DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Allegheny-Clarion district lies in the western part of Pennsylvania, on Allegheny River north of Pittsburgh. All of Venango, Forest, Clarion, and Armstrong counties are included in the district, and that part of Allegheny County lying north of Pittsburgh between Ohio and Allegheny rivers; Allegheny, Lower Burrell, Upper Burrell, Washington, and Bell townships of Westmoreland County; West Mahoning, South Mahoning, and the western part of Washington townships in Indiana County; Barnett, Millstone, Eldred, Union, Clover, Beaver, Ringgold, Porter, Oliver, Knox, Pine Creek, Rose, western half of Warsaw, and the western third of Polk townships in Jefferson County; also Allegheny, Parker, Fairview, Donegal, Clearfield, Winfield, Clinton, and Buffalo townships in Butler County.

GEOLOGY.

Practically all of the production from this area is from beds in the Allegheny group. This group has an extensive outcrop and the coals are easily accessible by drift along the principal drainage systems. The Conemaugh group is also present in large areas, but the coals are thin and are mined only for local farm use. The Pottsville series, lying below the Allegheny group, contains one or more non-commercial coals.

About twenty beds outcrop in this district, six of which produce coal for shipment, two others are mined when prices are high and demand excessive, and the rest are either too thin or too impure to be mined profitably at present.

Generalized section of coal beds in Allegheny-Clarion District.

Groups	Name of bed	Range in interval	Range in thickness of coal beds
Monongahela	Sewickley	80	
	Redstone	40	6" — 2' 0"
	Pittsburgh	490	6' — 10' 0"
Conemaugh	Bakerstown	70	6" — 4' 0"
	Brush Creek	40	0 — 2' 6"
	Mahoning	50	0 — 3' 0"
Allegheny	Upper Freeport ("E")	35-55	2' — 10' 0"
	Lower Freeport ("D")	40-50	2' — 6' 0"
	Upper Kittanning ("C'")	45-55	1' — 15' 0"
	Middle Kittanning ("C")	40-70	1' .. 3' 0"
	Lower Kittanning ("B")	70-90	1' — 5' 0"
	Clarion ("A'")	20-30	0 — 6' 0"
	Brookville ("A")		1' 6" — 4' 6"

DETAILED DISCUSSION BY BEDS.

Pottsville Coals.

The Pottsville series, outcropping in the northern part of this district, principally in Venango, Forest, and Clarion counties, contains one or more very lenticular coal beds ranging from 6 inches to 4 feet thick, and high in ash and sulphur. These beds have been opened at one or two places for farm use, but give little promise of future value.

Brookville ("A") Coal.

Distribution and character. This coal, lying at the base of the Allegheny group, ranges from 18 inches to 4 feet 6 inches thick, averaging 3 feet. It is deep under cover in Allegheny County, and although it has been located in several diamond drill holes and also in numerous oil and gas wells, little is known of its quality and thickness. It will probably be mineable in some areas. Farther north in Allegheny County this bed outcrops along Allegheny River, is lenticular, and extremely variable in quality; locally it is thick and the quality is good. The coal is hard, lustrous, and splintery. It is mined at many country banks for local use, but very few mines pro-

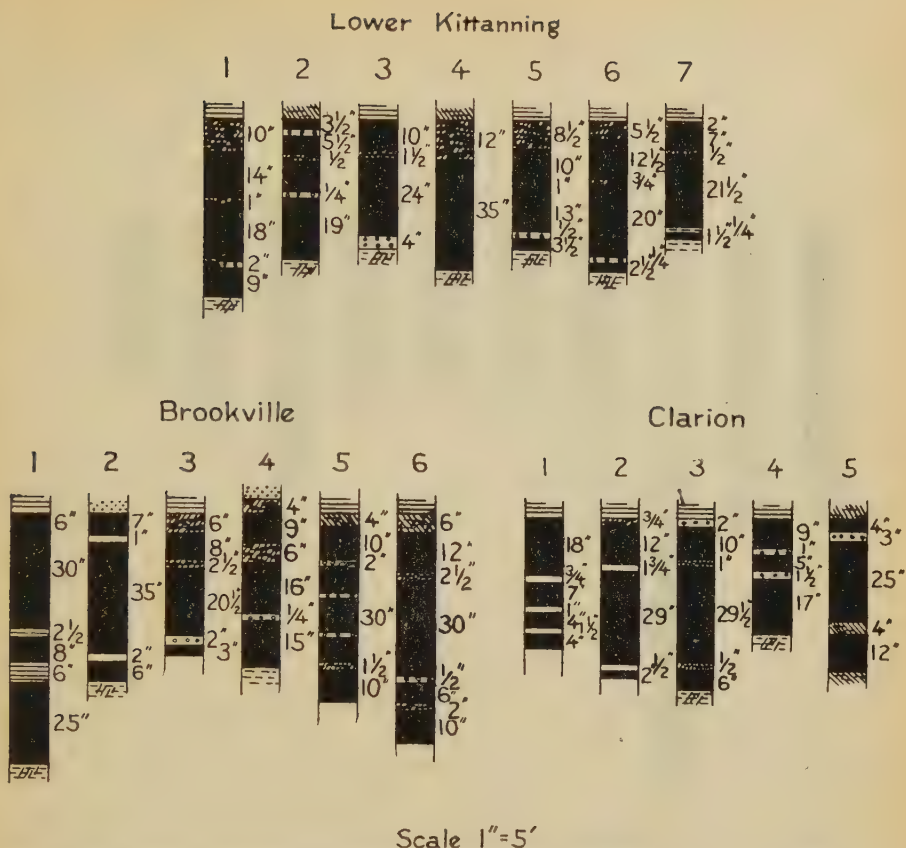


Fig.13 Sections of coal beds in operating mines in the Allegheny-Clarion District, Pa.

duce coal for commercial purposes. The bed ranges from 2 to 4 feet thick on Mahoning Creek, and is separated into two benches by a 2 to 8 inch shale parting. Outcrops of the bed on Crooked, Pine, and Cowanshannock creeks indicate that it has poor quality. At Buffalo Mills the bed is 3 feet 2 inches thick, has several shale partings, and is valuable only as a source of local fuel. On Rough Run the coal is 2 feet 6 inches thick, including two 1-inch bone partings.

The Brookville is very irregular in thickness in Clarion County. Locally it is 4 feet 6 inches thick along Clarion River in the eastern part of the district, but is rather dirty and high in sulphur. In the vicinity of Madison schoolhouse it is 2 feet 9 inches thick, including a 7-inch parting of shale and pyrite in the middle. Where

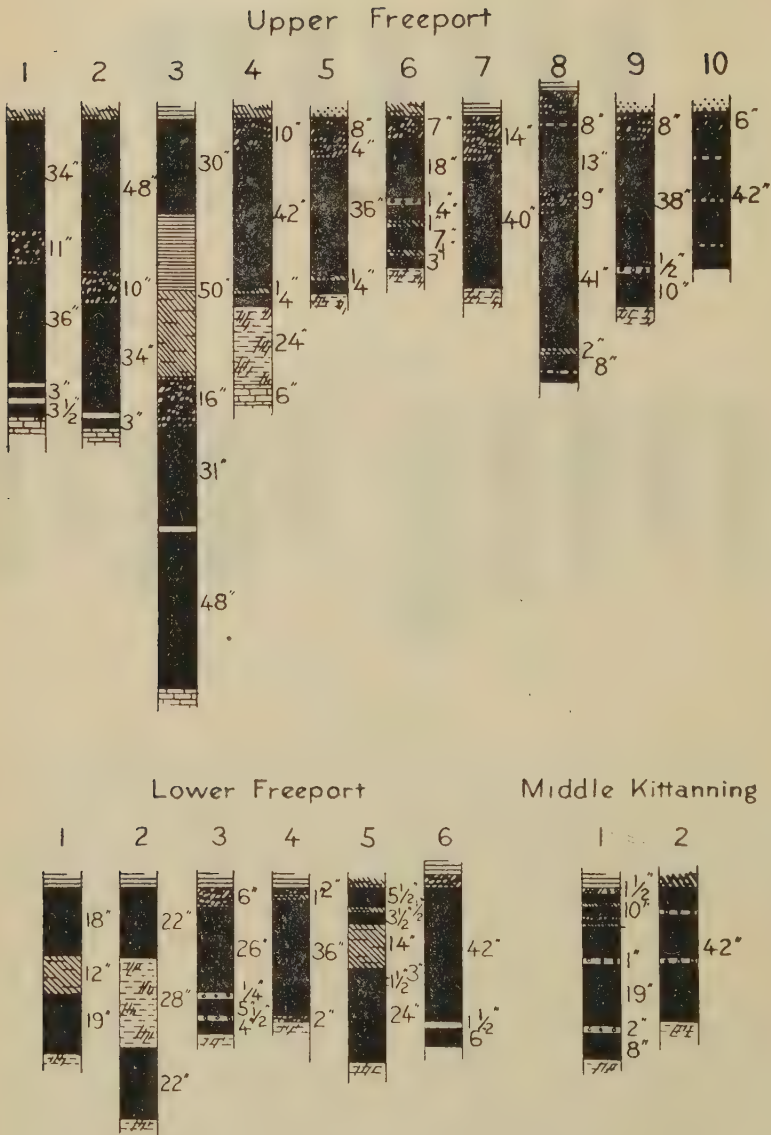


Fig.14 Sections of coal beds in operating mines in the Allegheny-Clarion District, Pa.

mined east of Kingsville and west of Sutton it is 2 feet 4 inches thick. At Sligo and northeast of New Bethlehem it is locally 3 feet thick, impure, and high in sulphur.

Near the eastern boundary of the district in the vicinity of Knox the bed is divided into several benches by thick shale partings, the distance from topmost bench to the bottom of the lowest being 15 feet. The bed is similarly parted at Shippensville, but southward the partings become thinner and disappear.

The coal is used entirely for steam purposes, and is shipped as run-of-mine. The roof is very hard shale and sandstone; the floor is soft clay. The cover ranges from crop to 700 feet.

Coal losses and mining methods. All the mines are drift. The system of mining is entirely room and pillar. The mines are small and are either worked on the royalty basis or on lease from large operators working in beds above the Brookville.

A mining system is entirely lacking in some mines and no attempt has been made to draw pillars. In others, principally those working on a royalty basis, the recovery is above the average in the district. About 25 per cent of the entire bed is lost in room, entry, and panel pillars. This loss is directly attributable to delay in retreat mining. The Brookville coal lies under heavy cover in the southern part of the district. Frequent squeezes exist because rooms are driven too wide. In the northern part of the district little attention is given to timbering work. Timbers rot, the roof falls, and large areas are lost because the companies do not have sufficient capital to drive through falls on the haulageways. A few mines are using machines. Machine men leave about 3 inches of coal on the bottom. In mines not using machines, miners leave about 1 or 2 inches of coal in order to keep the track from sinking into the soft clay. Much coal is lost in handling and preparation because coal which sticks to the numerous shale binders, is discarded on the gobs. The Brookville is extremely irregular in thickness in certain localities and large areas of coal are lost. These coal areas are not at present merchantable but have future value.

The average net width of main, cross, and panel entries is 11 feet. The average net pillar width between main and cross entries is 40 feet. The length of room necks is 20 feet, and the width 12 feet. Rooms are driven on 42 foot centers, 17 feet of which is pillar.

When this district is more fully developed and railroad facilities are improved this bed will probably be mined more extensively. When production is increased the recovery will probably



Figure 15

improve. The roof is hard and breaks easily and sharply favoring a good recovery in pillar work. The bottom is rather soft but should not hinder a large ultimate recovery if rooms were driven narrower and the pillar width increased.

Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	25	20
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	3	1
	36	25

Clarion ("A") Coal.

Distribution and character. The Clarion coal, like the Brookville, lies deep under cover in the southern part of the district, is extremely variable in thickness, and averages less than 12 inches thick in the district south of Mahoning Creek. It is thickest north of Mahoning Creek on Allegheny River. Here it ranges from 3 feet to 4 feet 8 inches thick, but is very pyritous and carries many bone and shale partings. At Parker City a 1 inch shale parting separates the bed into a 9 inch top bench and a lower bench 2 feet 8 inches thick. At the mouth of Mahoning Creek it ranges from 6 inches to 2 feet thick. At Buffalo Mills it is persistent and ranges from 2 feet to 2 feet 6 inches thick. The coal is worthless in the vicinity of Kittanning, but on Rough Run it is 2 feet 6 inches thick, including two 1-inch shale partings. It is mineable at West Winfield and is 2 feet 6 inches thick at Fairmont City.

The Clarion coal is one of the most important beds in the northern part of the district, occurring as two thick benches separated by 5 to 40 feet of shale. It is persistent and ranges from 2 to 7 feet thick, but contains a large quantity of iron pyrite and is known as the sulphur vein. It averages 4 feet thick on Allegheny River in Richland township, and is mined for shipment. It is parted 10 inches from the bottom by 16 inches of bony coal. The lower Clarion coal is mined near West Monterey, averages 3 feet thick, and has a persistent 1-inch band of pyrite 9 inches from the bottom. Where mined near Clarion it has a maximum thickness of 6 feet,

averaging 5 feet. It carries a 2-inch pyrite band 2 feet 5 inches from the top, 7 inches of bony coal 17 inches from the bottom, and is locally bony at the top.

The Clarion coal is thin and unmerchantable in the eastern part of the district where it averages less than 2 feet thick. The roof is soft shale, and the bottom soft clay.

Coal losses and mining methods. The Clarion coal is mined entirely by drift. The system of mining is room and pillar.

The average net width of main, cross, and butt entries is 11 feet. Pillars are 35 feet wide between main entries; between cross entries, 30 feet wide. The average length of room necks is 20 feet, the width is 12 feet. Rooms are driven on 45 foot centers. They range from 20 to 30 feet wide, the remainder being pillar work. The distance between room break-throughs is 75 to 100 feet.

Pillar removal has been attempted in several mines with very little success. The bottom is soft and the roof is very fragile. It does not break clean and fractures often run as far as 100 feet at right angles to the gob line, endangering headings some distance from the point where pillars are being robbed. General practice in mining this bed is to drive rooms wide, timber heavily, and attempt no pillar pulling until the mine is about to be abandoned. An attempt is then made to pull any pillars that have not been lost by squeezes and heaves or cut-off from the haulageways by roof falls. As is characteristic of mining systems of this type the loss in handling and preparation is very high. The bed is lenticular and local areas are very dirty. These physical characters promote an excessive loss in rolls and thin and dirty areas. Mining machines are used quite extensively and from 1 to 3 inches of coal is left on the bottom by machine men.

Coal losses in Clarion bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	35	29
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	1
	49	34

Lower Kittanning ("B") Coal.

Distribution and character. The Lower Kittanning coal, lying from 100 to 110 feet above the Brookville, is deep under cover in the southern part of the district. Its horizon has been noted in

numerous drill holes but there is little promise for future value because thinness and irregularity would prevent the expensive shafting operations necessary to mine it.

The Lower Kittanning is the most important bed in the central part of the district. It outcrops along the slopes of Allegheny River and its main tributaries. It is thickest west of a line drawn from Kellersburg through Kittanning. Within that area it is nearly everywhere over 2 feet 6 inches thick, averaging 3 feet 6 inches, and is locally 5 feet thick. It has many bone partings and is locally high in sulphur, although it is probably of mineable thickness in the whole area.

At Kittanning the bed is 3 feet 6 inches thick, has 3 to 4 inches of bony coal at the top, and carries small lenses of pyrite. At Cowanshannock it is 3 feet thick, not including 4 inches of bone coal at the top, and carries no partings; at Mosgrove 3 feet 11 inches thick, not including 4 inches of bone coal at the top; at Rimerton 3 feet 6 inches, with the characteristic bone coal at the top. In Madison township the bed averages 3 feet 8 inches thick, with approximately 5 inches of bone coal at the top. The bed thins to an average of 2 feet 6 inches in Mahoning and Red Bank townships, although a local thickness of 4 feet is not uncommon. There are no characteristic partings or binders, but numerous lenses of pyrite make the sulphur content high.

The average thickness of the bed in Wayne township is 3 feet, and maximum 5 feet. Partings and binders are rare. The coal thins to 2 feet 6 inches in the eastern part of Pine and Boggs townships, but thickens westward to the Allegheny. The bed is probably thickest in the northern part of East Franklin and Washington townships, averaging 3 feet 9 inches. It thins northward into Bradys Bend and Perry townships, where it averages about 2 feet 6 inches thick. Opposite Red Bank the bed is divided into an upper bench 4 inches thick, and a lower one 3 feet thick, by a 1-inch bone pyrite parting. Near Rimer the bed is 3 feet 2 inches thick, with 4 inches of bone coal at the top. Opposite Mosgrove it is 3 feet thick, including a 1-inch parting 4 inches from the top; at Furnace Run 3 feet 3 inches thick with the same parting. The coal probably thins to the western boundary of the district. In Reyburn and Valley townships the coal averages 3 feet thick. It varies greatly in thickness in the townships south of Kittanning on the Allegheny, but will average 3 feet thick, including a 1-inch bone parting about 4 inches from the top.

The Lower Kittanning coal averages 37.5 per cent volatile matter, 50 per cent fixed carbon, 3.5 per cent sulphur, and 8 per cent ash. The coal is bright, and has columnar cleavage. It is soft, but mines out in fair sized lumps.

The Lower Kittanning coal is the second largest producer in the district. The roof is shale and sandstone of medium hardness; the bottom, soft clay. The cover ranges from crop to 550 feet.

Coal losses and mining methods. The Lower Kittanning is mined entirely by drift along the slopes of the main drainage systems. The system of mining is room and pillar. The average net width of cross, panel, and main entries is 10 feet. The average width between main entries is 40 feet. The width between cross entries ranges from 20 to 50 feet. Room necks are 20 feet long and 12 feet wide. Rooms range from 20 to 40 feet wide, and the room pillars from 8 to 20 feet wide.

Absolutely no attempt has been made in the majority of mines to remove any kind of pillars. The total loss calculated is 42 per cent. It would be much greater if 40 per cent of the coal was not extracted on first mining.

The mines in this bed are an example of what mines should not be. There is very little indication of any mining plan; the haulageways and rooms are not driven on sights; the pillars are crushed and the floor heaved. Thousands of dollars are wasted yearly in futile attempts at trying to hold up the roof by timbering. If a system were installed wherein headings were driven to their full length and the same number of rooms turned off of each of these headings, and the gob line carried back at an angle of 45° to the main haulageways, this coal could be mined with great success. The pillars should be 40 feet wide instead of 8 to 20 feet, and the rooms from 15 to 20 feet wide instead of 20 to 40.

Much coal is lost in handling and preparation and in roly, thin and dirty areas. The coal breaks clean from the roof and no coal is lost on top. However, machine men leave from 1 to 3 inches on the bottom.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	30	25
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	3	1
	42	30

Upper Kittanning ("C") Coal.

Distribution and character. The Upper Kittanning coal, lying from 95 to 115 feet above the Lower Kittanning, is deep under cover in the southern part of the district. It is lenticular and extremely variable in quality. Little is known of its physical and chemical characteristics. Unlike the other coals of this district it is not a typical high volatile coal. Locally in the northeastern part of Armstrong County, some of the bed is cannel coal. The cannel coal occurs in long, narrow troughs, evidently old stream channels. In these troughs the lower part of the bed, usually about 2 feet thick, is overlain by cannel coal 5 to 13 feet thick in the axis of the trough, thinning to a feather edge on both sides. The average width of mineable coal in a trough south of New Bethlehem is not over 600 to 800 feet.

The bed is mineable in the vicinity of Sherrett and Peach Hill, at Somerville, at Kaylor, and possibly also on Cove Run in the central part of the district. At Somerville the coal and cannel shale is 13 feet thick in the center of a trough. The coal is thickest and best in Mahoning and Red Bank townships, where it occurs in several apparently isolated deposits of unusual thickness. It consists of cannel and bituminous coal in two to four benches. On Cathcart Run, and in other localities between Putneyville and South Bethlehem, the bed is locally 15 feet thick and is composed of four benches, two of bituminous and two of cannel coal. On the east side of Little Mudlick Creek, the Upper Kittanning coal has a maximum thickness of 13 feet 11 inches, 8 feet of which is cannel coal. In the Pine Creek region it has a persistent thickness of 2 feet 9 inches. It was once mined on the South Fork of Pine Creek, near Pine Furnace, and is 2 feet 8 inches thick. The Upper Kittanning coal is thin on Kiskiminitas River. It is 2 feet thick at Girty and Cochran Mills on Crooked Creek. On Cherry and Carnahans runs the bed has a maximum thickness of 3 feet, but averages much less.

The Upper Kittanning coal is used almost entirely for local fuel. Large operations have failed because of the extreme irregularity of the bed which makes mining unprofitable. The cover ranges from crop to 450 feet. The immediate roof is soft shale; the floor is soft clay.

Coal losses and mining methods. The mining system is presumably room and pillar, but the present practice is known as the ground-hog method. No attempt has been made to pull pillars. Fifty per cent of the coal is lost when practically all of the pillars could be extracted. The average net width of main entries is 12 feet; the cross

and panel entries are 18 feet wide, including about 6 feet of gob. Pillars are 40 feet wide between the main entries, and 30 feet wide between cross entries. The net width of side pillars is generally 30 feet. Room necks are 18 feet long and 12 feet wide. Rooms are 24 feet wide, and the room pillars 16 feet wide.

A great amount of coal is lost in handling and preparation. Much merchantable coal is discarded on the gob and lost on the roadways, mixed with motor sand, and becomes unmerchantable. Fully 3 per cent of coal is left on the bottom by machine men.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	50	45
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	2
	62	51

Lower Freeport ("D") Coal.

Distribution and character. The Lower Freeport coal lies from 40 to 50 feet above the Upper Kittanning. The interval is exceedingly variable on Allegheny River, and has led to an evident confusion of these two beds in the vicinity of Freeport. In northern Allegheny County an unusually thick coal bed at or near this horizon has caused a great controversy between coal men, some believing it to be the Lower Freeport, others the Upper Freeport, and some have advanced the theory that it is a combination of both. Mr. Ashley, State Geologist, and the writer, after checking all available data by field work have concluded that the "Thick Freeport" is beyond doubt the Upper Freeport. It will be discussed in this paper under that heading.

The Lower Freeport coal is present only locally in the northern part of Allegheny County. It is extremely thin and its horizon is generally marked by a few feet of bituminous shale.

The Lower Freeport coal is extremely variable in thickness west of Allegheny River in Armstrong County and is mined only for local use. At Cowansville and southward along Glade and Limestone runs and along Allegheny River the bed is locally 3 feet thick. The coal is persistent east of the Allegheny River. Where mineable it is 2 to 4 feet thick, and is a bright clean coal. In Madison, Mahoning, and Red Bank townships the coal has a local maximum thickness of 4 feet 6 inches. In several areas the coal averages 3 feet thick.

Locally a 2-inch bony parting, high in sulphur, divides the bed into two benches. In Pine, Boggs, Wayne, Valley, and Reyburn townships the coal has a local maximum thickness of 3 feet, but averages much less. It averages 2 feet thick in the southern part of the district on Kiskiminitas River.

On Cowanshannock Creek the bed has a fair thickness and the coal is clean. It is mined principally for local use. At Yatesboro the bed is 4 feet 6 inches thick, including a local 2-inch shale parting. On the South Fork of Pine Creek it ranges from 2 feet to 2 feet 6 inches. On the North Fork of Pine Creek its average thickness is 21 inches, with a maximum of 2 feet 6 inches. It is thin on Mahoning Creek, but north of Putneyville it is nearly 4 feet thick, including numerous bone partings near the roof and bottom. The bed is 3 feet 10 inches thick on Redbank Creek. A 3-inch bone parting separates an upper bench 16 inches thick from a lower one 2 feet 3 inches thick. At South Bethlehem it ranges from 3 feet 6 inches to 6 feet thick, but the coal is extremely shaly and carries much pyrite.

The Lower Freeport coal averages 33.5 per cent volatile matter, 52 per cent fixed carbon, 8 per cent ash, and 2.5 per cent sulphur. It is a typical high volatile coal. The cover ranges from crop to 400 feet. The roof is shale and sandstone of medium hardness; the floor, clay and shale of medium hardness.

Coal losses and mining methods. The Lower Freeport coal is mined entirely by drift on the slopes of the main streams in the district. It is not a large producer of commercial coal. The system of mining is room and pillar. The average net width of main, cross, and panel entries is 12 feet. Cross and panel entries are used for gobbing. The average net pillar width between main entries is 40 feet; between cross entries, 30 feet. The average net width of side pillars is 30 feet, and of chain pillars, 40 feet. Room necks are 18 feet long and 12 feet wide. Rooms are 24 feet wide, and the pillars 16 feet.

The mines in this bed are small and are not laid out on a definite plan. Headings are turned off into the thickest and most easily accessible coal. In most mines little attempt has been made to draw pillars. Large areas are lost due to squeezes and heaves. The roof often creeps in large areas. Probably some coal will be recovered when the headings have been driven to the property lines and abandonment of the mines begins. There is no excuse whatever for not drawing pillars.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	30	15
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	3	2
	42	21

Upper Freeport ("E") Coal.

Distribution and character. This bed, lying from 35 to 55 feet above the Lower Freeport, has great importance in the southern and central parts of this district. Although it is locally thin and dirty it averages over 3 feet thick. The Upper Freeport is the most important coal in the eastern and northeastern part of Allegheny County. It is persistent, but in a few places is too thin to mine. It ranges from 2 to 10 feet thick. Where thickest 2 feet of cannel coal is present at the top. A shale and bone parting ranging from 1½ inches to 2 feet thick is usually present in the bed about 2 feet from the top. When this parting exceeds 14 inches, the upper bench is not mined, and the parting is left as roof. Two binders of bony coal are invariably present, one about 5 inches, and the other about 12 inches from the bottom. Often the upper binder is used as bottom, and the two underlying thin benches of coal are not mined.

In the central part of the district in the vicinity of Bradys Bend and Queenstown the Upper Freeport is divided into four benches by shale and bone partings that lessen its value. The bed averages 2 feet 9 inches thick, and is a bright, good coal. Locally it is more than 4 feet thick. At Karns it is 5 feet; at Bradys Bend 4 feet 2 inches; at Leet, 4 feet, but very impure. It is mined at Cowansville, where it averages 3 feet 3 inches thick. Locally two thin binders are present; otherwise the coal is clean.

The coal has been eroded in large areas in the northeastern townships of Armstrong County. In the southern part of Madison township and in Pine township the coal is locally 5 feet 4 inches thick. It is lenticular, but will average 3 feet. A local band of pyrite 1 to 2 inches thick increases the sulphur content. The coal is very persistent and regular in thickness in Mahoning and Red Bank townships, ranging from 3 feet to 4 feet 4 inches, and averaging about 3 feet 4 inches. Locally there are one or two thin bone binders in addition to a 3-inch bone parting 8 inches from the bottom. In a few mines there are 4 to 6 inches of bone coal at the top of the bed.

The Upper Freeport coal is confined to some 50 hilltops along the southern border of Clarion County. It ranges from 18 inches to 6 feet 3 inches thick, not including persistent bony benches above and below the good coal. Next to the Lower Kittanning and Clarion coals it is the most important bed in the county. It is persistent and mineable in practically its entire area.

On Allegheny River in Boggs township the Upper Freeport coal averages 2 feet 8 inches thick and is free from partings and binders. Pyrite lenses are numerous in some places. The coal thickens eastward into Wayne township, averaging 3 feet 4 inches thick where mined at Dayton, including a $\frac{1}{2}$ -inch parting of bone coal and pyrite near the middle. The coal thickens to 4 feet 4 inches between Dayton and Echo, but is very dirty. At Echo the bed is 4 feet 2 inches thick, with a $\frac{1}{2}$ to 2 inch bone coal parting 4 to 10 inches from the bottom. The bed is also bony at the top.

The Upper Freeport is extremely variable in thickness in Cowanshannock township. At Sagamore it measures 6 feet including a 6-inch bone parting near the middle, a 1-inch shale parting near the bottom, two pyrite bands and 5 inches of bony coal at the top of the bed. At Yatesboro the bed is 4 feet 2 inches thick, including 6 inches of bony coal at the top, and a $\frac{1}{2}$ to 2 inch bone parting 4 to 8 inches from the bottom.

In Reyburn and Valley townships the Upper Freeport averages 2 feet 8 inches thick, and carries no distinct impurities except local lenses of pyrite. On Garrett Run and in Kittanning and Manor townships the coal thickens locally to 6 feet 6 inches including five thin partings. The average thickness is less than 3 feet.

The Upper Freeport coal averages over 3 feet thick in Bethel, Gilpin, and Parks townships. It ranges from 2 feet to 4 feet 6 inches thick, including local partings of bone and pyrite which are 6 inches thick in places. A few inches of bone coal is common at the top.

The Upper Freeport coal has great importance along Kiskiminitas River in the southern part of Armstrong County. It ranges from 2 feet 6 inches to 5 feet thick in Kiskiminitas township and averages 3 feet 9 inches thick. Small persistent bone partings lessen its value. At Apollo it is divided into two benches by a 1 to 2 inch bone parting. The upper bench is 2 feet 4 inches to 3 feet thick; the lower from 12 to 18 inches thick. The Upper bench is good clean coal, but the lower one is dirty.

The coal averages about 3 feet thick in South Bend, Burrell, and Plumcreek townships. The same characteristics are common across Kiskiminitas River in Westmoreland County, where the Upper Freeport coal is mined by shaft.

The Upper Freeport coal in this district is one of the largest reserves of high volatile coal in the State, if not in the entire eastern bituminous coal field. Large areas have not been mined and some are not as yet prospected.

Analysis of the Upper Freeport coal.

	Per cent	
	Range	Average
Volatile matter	33-36	34
Fixed carbon	52-57	54
Ash	5-12	7
Sulphur	1-4	2.1

The coal is soft, friable, brilliant in lustre, and breaks up when mined. The cover ranges from crop to 350 feet. The roof is shale and the floor is clay.

Coal losses and mining methods. The Upper Freeport coal is mined by drift everywhere in the district with the exceptions of about fifteen shafts in western Westmoreland and eastern Allegheny counties in the townships bordering on Allegheny River. The mining system is entirely room and pillar. The average net width of main, cross, and panel entries is 12 feet, and of chain pillars is 40 feet. The average net pillar width between main and cross entries is 40 feet. Room necks are 21 feet long and 12 feet wide. Rooms and room pillars vary greatly in width in the district along Allegheny River. At the Allegheny and Armstrong county line, rooms are driven on 40 foot centers, 16 feet of which is pillar work. Farther north along Allegheny River, in Armstrong and Clarion counties, rooms are driven on 45 to 50 foot centers. Rooms are 25 to 30 feet wide, and pillars average 20 feet thick.

Attempts at pillar pulling have only been made within the last few years. Modern operations have perfected a system which may be classed as room and pillar, and are quite successful in pulling pillars. However, the majority of the mines in this bed are small, owned by small companies which appear to care nothing for the value of the coal or its future possibilities. They make no attempt to draw pillars until the operations have been extended to their limits and then try to salvage part of the pillars from the wreck. As is characteristic of this system of mining much coal is lost in handling and preparation. In certain localities as much as 2 feet of coal is left above the characteristic parting. The operators claim that this coal is inferior in quality; the real reason for leaving it is the excessive cost of handling the thick binder.

Often from 2 to 12 inches of coal is left on the bottom underneath a parting. In addition to this loss machine men leave from 1 to 3 inches of coal on top of the parting.

In most mines rooms are gouged on the sides, enlarging them in some cases to 35 and 40 feet wide with 10 to 15 foot pillars. These pillars, of course, are squeezed and crushed. The roof falls in the butt headings and large areas are lost because of the expense of removing these falls. Coal is also used in many mines to ballast track. The roadways are not kept clean and much coal is ground into the clay bottom and mixed with motor sand.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	30	25
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	0
	44	29

Coals in the Monongahela group.

The Pittsburgh bed is mined in a small area in the extreme southeastern corner of Armstrong County. The Redstone and Sewickley coals lie above it, are thin and dirty, and not mined. The Pittsburgh coal is discussed in the report on the Indiana District.

CONCLUSION.

The wanton waste of coal in this district which will be needed by future generations for use in making gas is entirely unwarranted and should be prevented. This district contains several beds which range from 33 to 36 per cent volatile matter. The sulphur and ash are rather high, but with proper preparation these coals may eventually compete with the renowned gas coal from the Irwin basin. The Pittsburgh bed in the Irwin basin is practically exhausted; the mines are now operating entirely on pillar work; and very few acres of virgin coal remain. In the near future the Allegheny-Clarion district will be called upon to produce practically all of the gas coal from the State of Pennsylvania. Unless mining conditions are improved, 40 per cent or more of this coal will be lost without excuse. If the mines were planned systematically, the rooms driven narrow and the pillars wide,

40 per cent of the coal removed on first mining and 60 per cent on the last, millions of tons could be saved yearly, and a loss like that of the Pittsburgh coal on the Monongahela River could be prevented.

Practically all the mines in the district are non-union. The writer did not observe any loss of coal directly due to attitude of labor. The miners can be moved from place to place at the operators convenience. An established price is paid to miners and there appears to be very little dissatisfaction between operators and their employees.

The living conditions along Allegheny River as far north as Kittanning are fairly good, but north of that place along Allegheny River and its main tributaries, Mahoning Creek and Clarion River, the companies are small and the living conditions in their villages are very bad. Little attention is paid to the welfare of the employees, the houses are poor, transportation facilities are inadequate, and the sanitary conditions, particularly in time of dry weather, are extremely bad.

Summary of coal losses in Allegheny-Clarion district.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	30	25
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	3	1
	42	30

CHAPTER IX

OHIO-PYLE-LIGONIER DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Ohiopyle-Ligonier district is in the southwestern part of Pennsylvania, west of Laurel Ridge, and in the eastern part of Fayette and Westmoreland counties. The following townships are included in the district: Fayette County, Henry Clay, Stewart, Springfield, Saltlick, eastern half of Wharton, and the eastern third of Dunbar; Westmoreland County, Donegal, Cook, Ligonier, and the southern third of Fairfield.

GEOLOGY.

This district is in a long narrow basin extending from the southern State line north to Conemaugh River. The Pottsville series, which marks the lower boundary of merchantable coals, outcrops on the crest of Laurel and Chestnut Ridges. The Allegheny group, containing the valuable Kittanning and Freeport coals, underlies the entire district. The Conemaugh group, containing numerous coals which are too thin to be mined at present, underlies practically the entire district. The Monongahela group, containing the Pittsburgh coal, has been entirely eroded from the district with the exception of a few hilltops north of Ligonier in Ligonier and Fairfield townships.

About twenty coal beds outcrop in this district, five of which produce coal for shipment, three others are mined for farm use, and the rest are either too thin or too impure to be profitably mined at present.

Generalized section of coal beds in Ohio-pyle-Ligonier district.

	Name of bed	Average interval	Range in thickness of coal beds
Monongahela 400	Washington	120	0 — 2' 0"
	Waynesburg	115	0 — 10' 6"
	Uniontown (Benwood?)	145	0 — 2' 0"
	Sewickley	75	0 — 1' 0"
	Redstone	65	0 — 6' 6"
	Pittsburgh	280	5' 0" — 8' 0"
Conemaugh 645	Duquesne	35	0 — 1' 2"
	Harlem	60	0 — 4' 0"
	Bakerstown	170	0 — 7' 4"
	Brush Creek	45	0 — 1' 6"
	Mahoning	55	0 — 3' 0"
Allegheny 285	Upper Freeport ("E")	60	0 — 7' 0"
	Lower Freeport ("D")	50	0 — 5' 0"
	Upper Kittanning ("C")	40	0 — 5' 0"
	Middle Kittanning ("C")	40	0 — 5' 0"
	Lower Kittanning ("B")	60	0 — 5' 0"
	Clarion ("A")	35	0 — 3' 6"
	Brookville ("A")		0 — 5' 0"

DETAILED DISCUSSION BY BEDS.

Brookville and Clarion Coals.

These coals, lying between the Lower Kittanning coal and the top of the Pottsville conglomerate, have been prospected at many points, but only in rare instances were they of commercial quality. The Brookville coal is a thick bed containing many bone and shale partings. It averages probably 20 per cent ash and 4 per cent sulphur. The Clarion bed is generally much thinner but has better quality. This bed has been opened by farmers for domestic use. In two localities it is reported a fair smithing coal.

Lower Kittanning ("B") Coal.

Distribution and character. This bed is geologically the lowest coal mined commercially in the district. It outcrops along Youghiogheny River and its tributaries in the southern and along the slopes of Laurel and Chestnut ridges in the northern part of the district. This bed lies deep in most of the district and little is known of its thickness or quality. Large areas are untested and very few mines have been opened in it.

The Lower Kittanning averages less than 2 feet thick in the district. It is thickest and best on Indian Creek where mined extensively for use as a steam coal. The bed averages 3 feet 8 inches thick, and contains an average of 3 per cent sulphur. The roof is either hard shale or sandstone. The bottom is invariably clay. The bed averages 3 feet 4 inches thick in the vicinity of Confluence and in Youghiogheny River valley, including 4 to 6 inches of bony coal, invariably present at the top. This bony coal is separated from the main bench in most localities by a bone parting one-half inch thick. The main coal locally has one or two bone binders near the middle from 1 to 2 inches thick.

The coal ranges from 1.8 to 8.0 per cent sulphur, and from 4.1 to 20.8 per cent ash.

The thickness of cover ranges from crop to 400 feet. The interval to the next workable bed above, the Upper Kittanning, ranges from 75 to 95 feet; the interval to the underlying bed, the Clarion, is about 60 feet.

Coal losses and mining methods. All the mines are drift. The net width of main entries is 10 feet; of cross entries, 12 feet; of panel entries or butts, 12 feet. The average net pillar width between main entries is 70 feet; between cross entries, 50 feet. Side pillars range from 50 to 100 feet thick. The panel pillars are generally 75 feet thick. The system of mining is entirely room and pillar. Rooms are driven on 50 foot centers, 25 feet of which is pillar.

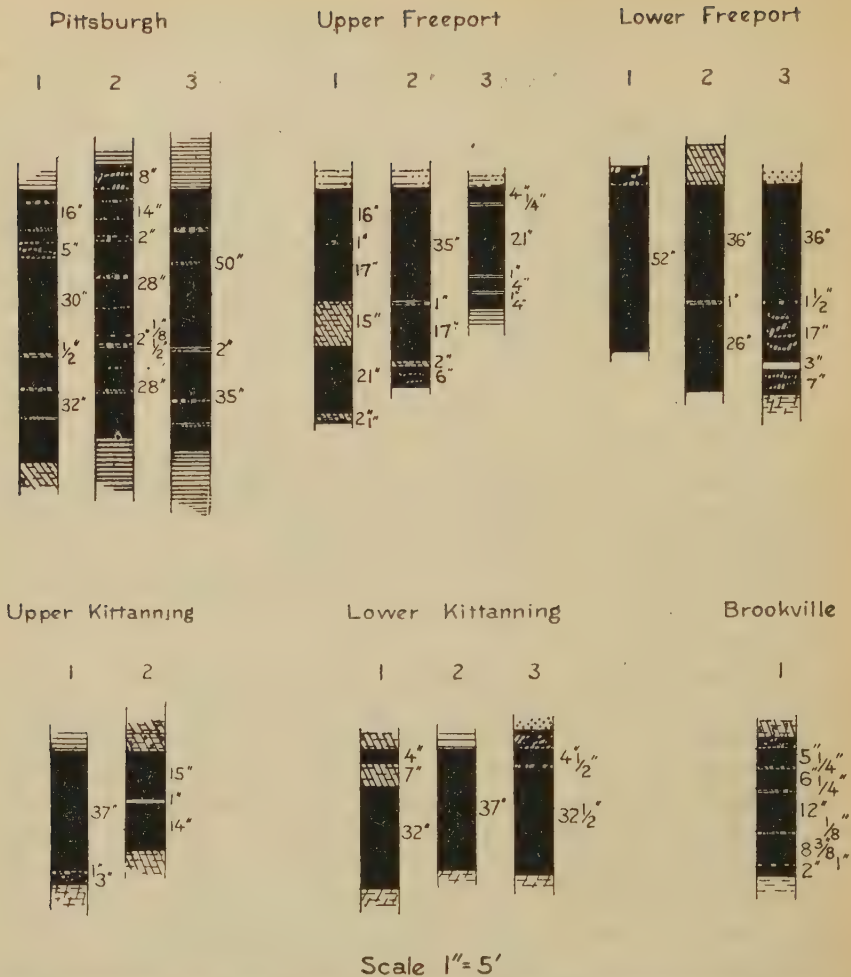


Fig.16 Sections of coal beds in operating mines in the Ohiopyle-Ligonier District, Pa.

The mines in this coal are generally very small. Most of them were opened during the war when excessive prices for coal prevailed. Little attention has been paid to laying out the mines, the only thought being to procure a large quick output at minimum cost. Many operators have made an attempt to pull pillars in these ground-hogged areas but find that the coal is crushed and the bottom has heaved so much that prohibitive costs have compelled them to leave large areas of pillars. The system of mining has greatly improved since 1918 as the great future value of the coal has become recognized.

A great quantity of coal is lost due to rolls and clay veins. In large areas bottom rolls cut the bed down to 18 inches or less. Headings are driven through these thin areas but no rooms are turned off.

Practically all of this thin coal will be lost. The bed also contains many clay veins and a shell of coal is left around them. Machine men leave an average of about 2 inches of coal on the bottom. Locally a few inches is left on the top of the bed to hold up the shale.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	8	4
In room, entry, and panel pillars	15	10
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	0	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	15	5
	42	21

Upper Kittanning ("C") Coal.

Distribution and character. This bed, lying 75 to 95 feet above the Lower Kittanning, is the most valuable bed along Youghiogheny River where it is mined by drift. At Confluence the bed averages 3 feet 6 inches thick, including 1 inch of shale and 3 inches of bony coal at the bottom. In a great many areas the bed is double, with clay partings ranging from 6 inches to 6 feet thick. The upper bench of good coal ranges from 18 inches to 3 feet thick; the lower from 12 inches to 2 feet 6 inches. In the vicinity of Ohiopyle the bed is 2 feet to 3 feet 6 inches thick, has many thin bone partings, and although very clean locally is generally rather inferior. Locally the bed has 6 inches of draw slate on top. The roof is generally hard shale or sandstone; the bottom is invariably medium hard clay. In the northern part of the district, particularly in Ligonier and Cook townships, the bed averages about 20 inches thick. Little is known of its extent and character because no mines have been opened in it. The bed is mined entirely by drift. The distance to the next overlying bed, the Lower Freeport, ranges from 45 to 55 feet.

Coal losses and mining methods. The system of mining is entirely room and pillar. The average net width of main entries is 11 feet; of cross entries, 12 feet; of panel entries or butts, 11 feet. The pillar width between main entries is 30 to 45 feet; between cross entries, 25 feet. The average net width of side pillars is 35 feet. Rooms are generally driven on 35 foot centers. Room pillars range from 10 to 18 feet thick according to thickness of cover. The roof and bottom are generally very hard and regular, and little trouble is experienced with rolls. The machine men leave very little coal on the bottom. In some localities a local draw slate at the top is held up by 2 or 3 inches of coal because of the prohibitive cost of loading the draw slate.

Little attention has been given to laying out these mines systematically. The butt headings are extended too far and too many

rooms are turned off before retreating is started. Large acreages of coal have been lost under cover by squeezes and heaves. In some places mines have even lost their main headings. The pillars are entirely too narrow under heavy cover. Much coal could be saved by better methods in handling and preparation both underground and on the surface. In mines having one or more bone or shale binders, 2 or 3 inches of good coal is discarded with these binders by men who pick the coal on the cars. Very little attention is given to a systematic and even break-line.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin and dirty areas	10	5
	32	16

Lower Freeport ("D") Coal.

This bed, lying about 50 feet above the Upper Kittanning, is the most irregular bed in the Allegheny group in this district. It ranges from a few inches to 5 feet thick, carries numerous bone or clay partings, and never is clean. Where thickest the partings are more numerous.

This bed has been mined on Indian Creek where its maximum thickness is 5 feet, including at least two binders having a total thickness of over 12 inches. The top bench, usually 3 feet thick, is good coal; the lower bench is seldom mined. Several mines were opened when prices of coal were high, but it is doubtful if these small mines can be operated at a profit in normal times. The bed is thin and worthless almost everywhere in the vicinity of Ligonier, its average thickness being less than 18 inches.

Most of the mines in this bed are now abandoned and the writer was able to inspect only one. The mining system was presumably room and pillar. Practically all the pillars were lost and much coal was left on the top and bottom. This percentage does not affect the total percentage of the entire district to any great degree because this bed produces very little coal.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	10	5
In room, entry, and panel pillars	30	20
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	10	5
	55	32

Upper Freeport ("E") Coal.

Distribution and character. This bed is 50 to 60 feet above the Lower Freeport and is the most persistent of the Allegheny coals in this district. Its thickness varies from a few inches to 7 feet. The coal varies from clean to dirty with many partings and much iron pyrite.

Many openings have been made recently in Henry Clay and Stewart townships. The coal shows great variation in quality and thickness. In Henry Clay township it averages almost 6 feet thick, including a shale parting ranging from 9 to 15 inches thick, 2 feet above the bottom, and a bony binder about 18 inches below the roof. In Springfield township it averages about 4 feet 2 inches thick, including two or three shale partings 1 to 3 inches thick. The lower 6 inches is very poor quality.

The Upper Freeport coal will be very valuable in the future in some areas in the northern part of the district. It is apparently thin on Laurel Ridge, thickening toward the center of the basin and to its western outcrop on Chestnut Ridge. The entire bed will probably average about 3 feet thick in the northern part of the Ohiopyle-Ligonier district.

The roof invariably is hard shale and sandstone; the bottom, soft clay. The cover ranges from crop to 350 feet. The distance to the next overlying bed now being mined is 600 to 655 feet; to the underlying bed about 55 feet.

Coal losses and mining methods. All the mines in this bed are drift. The system of mining is room and pillar. The average net width of main entries is 11 feet; of cross entries, 11 feet; of panel entries or butts, 14 feet. The average net width of pillars between main entries and of chain pillars is 40 feet. Rooms are driven on 45 foot centers, 15 feet of which is in pillars.

The roof is fairly good in most localities; the bottom is roly in places. Very little coal is left on top and bottom. Practically all the work is pick especially in the vicinity of Ligonier. The mines are small but are fairly well laid out. Pillar drawing has been practiced with much success although pillars are very narrow. These narrow pillars have been troublesome, but appear to be sufficient where the cover is less than 200 feet. Where cover is thicker, extra timbering is necessary. Most mines in this bed are new and little pillar drawing has been done. The writer estimated rather than observed the probable loss in pillars.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	3	1
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	5	3
	24	11

Pittsburgh Coal.

Distribution and character. This bed is present only on the high divides in the center of the basin in Ligonier and Fairfield townships, and underlies only a little more than 3,000 acres. Most of it has been mined out. The upper division is seldom over a few inches thick. The lower division averages about 6 feet 10 inches thick, including a bone coal parting 3 inches thick at various distances below the roof. A hard shale parting averaging 6 inches thick is locally present about 2 feet 4 inches from the bottom.

Sulphur ranges from 1 to 3 per cent., and ash from 6 to 9 per cent. Fixed carbon averages 64 per cent and volatile matter 24 per cent.

Coal losses and mining methods. All the mines in this bed are drift. The system of mining is room and pillar. The average net width of main and cross entries is 9 feet; of panel entries or butts, 10 feet. The average net width between main and cross entries is 40 feet. Side pillars are 60 feet wide; chain pillars 45 feet wide. Rooms are driven on 39 foot centers, 25 feet of which is in room pillars. Practically all mining is by pick.

The roof is shale, soft in places, and locally is treacherous. The bottom is soft clay which heaves easily. The maximum cover is 90 feet, the average being less than 40 feet. Pillars have been removed fairly clean, the greatest loss being in the mines where the headings have caved. In some areas timbering was insufficient and the roof caved before retreating was begun. Too much coal is being lost in handling and preparation. The rooms are not cleaned up before drawing pillars and miners discard an appreciable quantity of coal which sticks to partings.

Coal losses in Pittsburgh bed.

	Total	Avoidable
On roof and bottom	2	2
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin and dirty areas	2	0
	21	10

CONCLUSION.

The coal from this district is used entirely for steam and domestic purposes, most of it being shipped east and used by railroads. Very little prospecting has been done in this area but the writer believes it has promise of great future value, particularly after the adjoining areas of Pittsburgh coal have been exhausted. Attempts to coke this coal have been unsuccessful because of the high sulphur content. With the installation of washeries and picking tables the coal from this district will have great value as steam coal, and may be coked locally.

This district is in a very sparsely populated area and mining towns are situated along railroads. These towns are very small and draw their population from rural communities. A large part of the labor is drawn from nearby farms, particularly during the winter. Labor difficulties are few and the labor force is mobile.

Summary of coal losses in Ohiopyle-Ligonier District.

	Total	Avoidable
On roof and bottom	8	3
In room, entry, and panel pillars	13	7
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	11	4
	37	16

CHAPTER X

INDIANA DISTRICT

LOCATION AND GEOGRAPHIC EXTENT.

Indiana district lies in the central part of the bituminous coal field of Pennsylvania, and northwest of Johnstown. All of Indiana County is included with the exception of East, West, South, and North Mahoning townships, Canoe, Banks, Grant, Montgomery, and the northern half of Washington township. St. Clair township and the northern half of Fairfield township, Westmoreland County, are also included in the district.

GEOLOGY.

This district has, for many years, been one of the most important bituminous coal producing districts in Pennsylvania. The greatest output is from the Upper Freeport bed, which is the largest reserve of valuable and easily accessible coal in the district. The Lower Kittanning, Lower Freeport, and Pittsburgh beds are also important locally as sources of shipping coal, and many other beds have future value but are not mined at present.

The thick coal beds of the Allegheny group, including the Kittannings and Freeports, are also large reserves for future use. Practically all the mining is by drift, although there are extensive areas where these beds are within easy shafting distance. The Pittsburgh bed is restricted to a small area in the southwest part of the district, and will be exhausted within a few years.

There are at least fifteen beds in the district, but only four of these are at present producing shipping coal, three others may have future importance, and the remainder are thin and dirty, although they may be locally mineable.

Generalized section of coal beds in Indiana District.

Name of bed		Average interval	Range in thickness of coal beds
Monongahela	Sewickley	80	6" — 5' 0"
	Redstone	45	6" — 3' 0"
	Pittsburgh		6" — 10' 0"
Conemaugh 650	Coal	400-425	0 — 2' 0"
	Coal	70-100	0 — 1' 8"
	Coal	40-60	0 — 2' 0"
	Coal		
Allegheny 295	Upper Freeport ("E")	50-75	1" — 7' 0"
	Lower Freeport ("D")	25-80	6" — 16' 0"
	Upper Kittanning ("C")	40-80	6" — 5' 0"
	Middle Kittanning ("C")	30-50	0 — 2' 0"
	Lower Kittanning ("B")	35-70	0 — 5' 0"
	Clarion ("A")	50-85	0 — 1' 0"
	Brookville ("A")	20-55	0 — 4' 0"

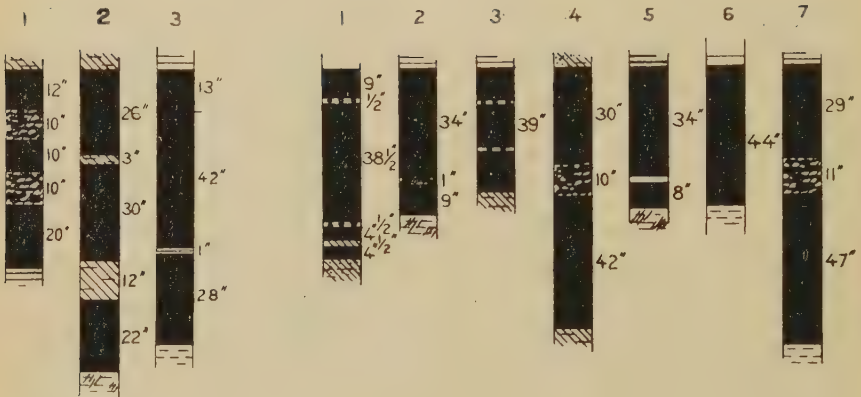
The coals in the Mercer group in the Pottsville are not mineable in this district. On Black Lick Creek, a coal in the Pottsville series is locally 14 inches thick, but appears to be very lenticular.

The Conemaugh group contains numerous thin coal beds, three of which are recognizable throughout the entire district. These beds are much thinner than the ones being mined but may have some future importance when the thicker beds are exhausted.

The Redstone and Sewickley beds, lying above the Pittsburgh, are confined to a few hilltops on the Armstrong-Indiana county line a few miles north of Kiskiminitas River. These beds are impure and irregular in thickness, and have been leached by surface waters until all commercial value has been destroyed. They have been opened only by the farmers seeking supplies of domestic fuel.

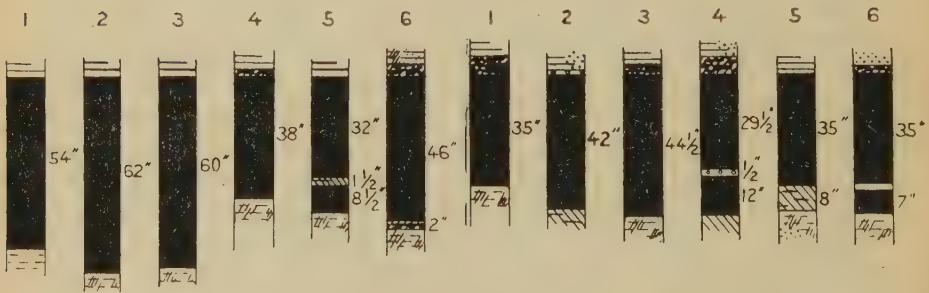
Pittsburgh

Upper Freeport



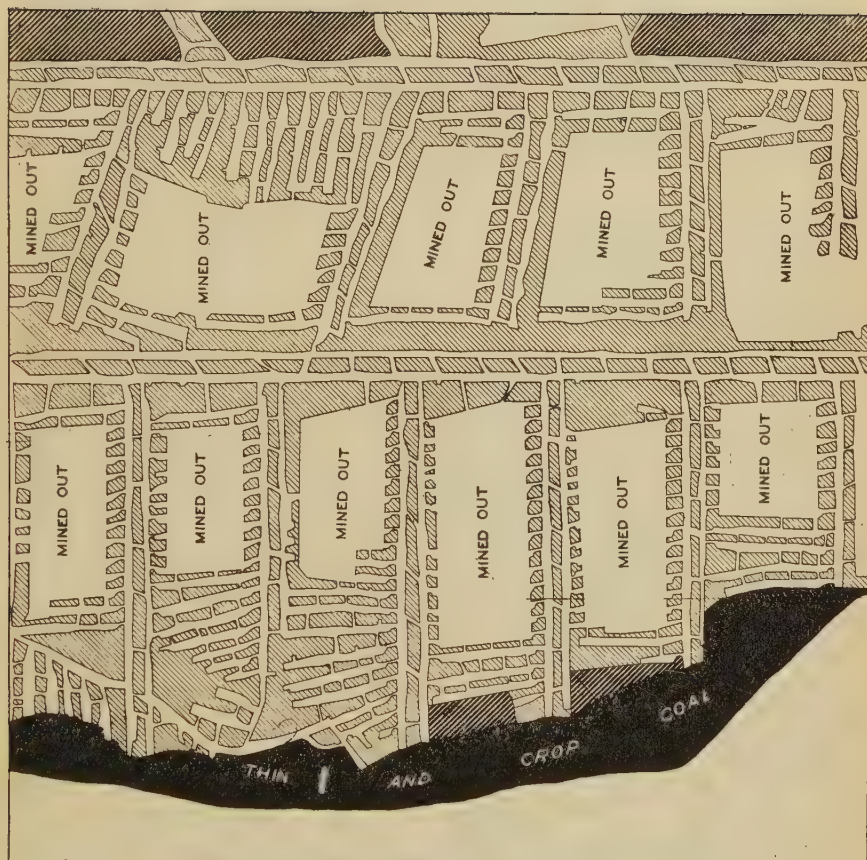
Lower Freeport

Lower Kittanning



Scale 1"=5'

Fig.17 Sections of coal beds in operating mines in the Indiana District, Pa.



SECTION OF MINE MAP
Indiana District, Pennsylvania
Losses in thin and crop coal

Virgin Coal

Coal to be recovered
in whole or part

Coal Lost

Scale
400 200 400 800 Feet

Figure 18

DETAILED DISCUSSION BY BEDS.

Brookville ("A") Coal.

This bed, lying a few feet above the Pottsville sandstone, is generally very impure, high in sulphur, and varies greatly in thickness. At Old Conemaugh Furnace it is 4 feet thick, and at Bolivar, ten miles down the Conemaugh, only 18 inches. In Black Lick Creek at Heshbon and Bells Mills it is between 3 and 4 feet thick, and has been used for steaming purposes and for burning brick. It is extremely high in ash and sulphur. In Pine township it ranges from 2 feet 2 inches to 3 feet 10 inches thick.

Clarion ("A'") Coal.

This coal, lying 20 to 55 feet above the Brookville, is thin, but very persistent, averaging 6 inches thick. It is mined locally, but does not figure in the production of the district. The recovery in this bed is 65 per cent.

Lower Kittanning ("B") Coal.

Distribution and character. This bed is about 100 feet above the Pottsville sandstone, and 190 feet below the Upper Freeport coal. It is below drainage practically everywhere in the district, and few openings have been made in it. The bed does not average more than 2 feet in the district, although it has a maximum thickness of 5 feet in local areas. It generally has 3 to 4 inches of bony coal at the top. Its floor is fire clay and is persistently roly. The shale roof is always regular. There are no persistent partings or binders, although locally there is a thick clay parting near the middle. Local lenses of pyrite are common.

The Lower Kittanning is important on Conemaugh River and on Black Lick Creek. It averages 2 feet 10 inches thick at Boltz, and locally thickens to 3 feet 2 inches, and has 5 inches of bone on top. It is 3 feet 2 inches thick in Robindale shaft, where it is mined for use in the Penn Public Service power plant; 4 inches of top coal are locally bony. The bed is 5 feet 3 inches thick at Lockport, including a 3-inch parting of bone and shale 18 inches from the bottom, and 6 inches of bone coal at the top. It is very high in sulphur, made so by numerous lenses of pyrite. The Lower Kittanning coal is mined extensively at Robinson (Bolivar), where it varies from 3 feet 6 inches to 5 feet thick. It carries a few inches of bone coal on top. A local binder from 1 to 6 inches thick is sometimes present 18 inches above the bottom. The coal is locally very clean, but tends to be rather high in sulphur. The Lower Kittanning coal is mined extensively on Black Lick Creek east of Josephine, where it is 3

feet 4 inches thick, and has 4 inches of bone coal on the top. The coal ranges from 2 feet 4 inches to 4 feet thick at Heshbon. The bottom is very roly, and there are 2 inches of bone coal at the top. The bed is 3 feet 10 inches thick at Scott Glenn, but contains many lenses of pyrite.

The Lower Kittanning is deeply buried in most of the southwestern part of the district. It outcrops at a few points on Crooked Creek where it averages 2 feet 6 inches thick, but it is extremely high in sulphur. The coal is 3 feet 6 inches thick where mined in Center township, and has 3 to 4 inches of bone coal on top. It is locally 3 feet 10 inches thick in Armstrong township. There are many old openings in this bed southeast of Indiana, where the coal is used for domestic purposes. On Furriers Run the coal is 3 feet thick; on Yellow Creek, 3 feet 6 inches. One mile above Ramsey Run on Two Lick Creek the bed is 6 feet 2 inches thick, including a 16-inch shale parting 14 inches from the bottom. Just above Allen Run on Two Lick Creek the bed is 7 feet 2 inches thick, including a 12-inch shale parting 2 feet 6 inches from the bottom. There are several openings in the Lower Kittanning coal on Penn Run and its tributaries. At Greenville it is 3 feet 10 inches thick; at Atherson's on the North Fork of Penn Run, $1\frac{1}{2}$ miles due north of Greenville, it ranges from 3 feet 10 inches to 4 feet 3 inches thick. The coal is mined extensively at Clymer, where it averages 3 feet 3 inches thick, not including a few inches of bone coal at the top. Drilling in the eastern part of the district, where the Lower Kittanning coal is deep under cover, indicates that it is locally thin, but mineable in large areas.

The roof of the Lower Kittanning is generally hard shale that breaks well. The bottom is shale and hard clay.

Coal losses and mining methods. Practically all mines in this bed are drift, and the mining system is entirely room and pillar. The entries are 12 to 20 feet wide. The chain pillars are 75 to 80 feet wide, and barrier pillars, 100 feet wide. The rooms are generally driven on 50 to 55 foot centers, 25 feet of which is pillar.

The greatest loss, except that in pillars, is due to machine men leaving from 3 to 8 inches of coal on the bottom. The bottom is very irregular locally and the machine men step-up over the rolls. This coal is scrapped by only a few companies.

A great many of the mines are not laid out properly; the entries and rooms are not driven on sights. Operators turn off too many rooms on the butt headings in order to increase production in times when the demand is great. These rooms are allowed to stand idle, the roof caves, and in a great many instances large areas are abandoned because these costly falls prevent the extraction of the coal at a profit. The pillars are drawn fairly well, but stumps containing 30 to 100 tons of coal are left. If these stumps

were removed with the pillar and not allowed to stand a few days and be covered with the break, the percentage of recovery would be much higher. Idle days are the principal cause of this loss.

Creeps and squeezes are induced by driving too many rooms, and by not keeping a uniform size of pillar. The miners gouge out the ribs, and often only a few feet remain between the rooms. The pillars, instead of being allowed to stand, should be drawn as soon as the rooms are driven up, in order to have the roof break next to the solid coal, thereby eliminating to a great extent creeps and squeezes which are prevalent.

The Lower Kittanning is very irregular in thickness in some localities, and large areas of thin coal are left to be mined at some future time. These thin areas probably will not be recovered. In other areas, binders in the coal make operating unprofitable at the present time. Many tons of good coal are lost because of added expense of removing these binders and hauling them to the surface. In some mines there is excessive loss because coal sticking to these partings and binders is discarded on the gob. In the smaller mines tracks are sometimes ballasted with a mixture of coal and bone. This practice should be prohibited. Overloaded cars often drop much coal along the headings, and when headings are cleaned this coal is either discarded on the gob or hauled outside and dumped.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	8	6
In room, entry, and panel pillars	14	8
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	6	2
	34	18

Middle Kittanning ("C") Coal.

This bed, lying 35 to 70 feet above the Lower Kittanning coal, is thin and unimportant, but has been opened for house coal in a few places. Its maximum thickness is 2 feet, and its average is approximately 6 inches. It measures 18 inches on Black Lick Creek; 16 inches on Two Lick Creek; and is locally 2 feet thick on Mahoning Creek.

Upper Kittanning ("C'") Coal.

This bed, lying about 100 feet above the Lower Kittanning, is also thin and unimportant. Near Deckers it is 5 feet thick, and locally it is overlain by 4 feet of cannel coal. South of Richmond a 5-foot bed of clean coal is probably at the horizon of the Upper Kittan-

ning. It is locally 4 feet thick on Black Lick Creek, but is extremely variable in thickness and very bony and high in sulphur.

The mining methods employed in this bed are identical with those employed in the Lower Kittanning. The mines are all small. *The percentage of recovery is 70.* The greatest loss is in coal left on the bottom by machine cutting, and by leaving stumps in pillar pulling.

Lower Freeport ("D," Moshannon) Coal.

Distribution and character. The Lower Freeport lies 40 to 80 feet above the Upper Kittanning coal in Indiana County. The coal ranges from 12 inches to 16 feet thick, and varies from a clean coal of excellent quality to a coal high in sulphur and ash.

The Lower Freeport is thin and irregular in all the townships south of Indiana, averaging less than 2 feet thick; furthermore it is high in sulphur. In local areas between Black Lick and Homer City the bed is 3 feet thick, including a 2-inch bone parting 4 inches from the bottom. On Neal Run, near Jacksonville, the maximum thickness of the coal is 2 feet 2 inches. On the divide between Dixon and Buck runs, one mile north of Two Lick Creek, the coal is 4 feet 4 inches thick. South of Dixonville it ranges from 3 feet 6 inches to 4 feet; one-half mile north of Dixonville it is 4 feet 3 inches thick. The coal is excellent, although locally there are many small bands of pyrite scattered through it. The bed ranges from a few inches to 4 feet 9 inches thick in Armstrong township.

The only development of the Lower Freeport in the district east of Indiana is at Heilwood, where the bed has a maximum thickness of 3 feet 6 inches. The coal is clean, low in sulphur and ash, and mines out in large lumps. In Grant township, between Richmond and Mahoning Creek, the bed averages 2 feet 6 inches thick in a small area. Locally it has 5 inches of bone coal at the bottom, and a 1-inch bone binder 10 inches above the bottom.

The Lower Freeport coal averages about 27 per cent volatile matter; 59 per cent fixed carbon; 9 per cent ash; and 1.5 per cent sulphur. In general it is a hard, compact coal which mines out in good sized lumps. Its extreme irregularity in thickness has greatly hindered its development, and will continue to do so until the more valuable Upper Freeport coal has been exhausted.

The coal is medium size when loaded, and is shipped to northern and eastern markets for steam and by-product uses. The first mines were opened in this bed in 1902. The roof is black sandy shale; the bottom is soft fire clay.

Coal losses and mining methods. Practically all the mines in the Lower Freeport coal are drift. The main entries are driven 12 feet wide, and the cross and butt entries 20 feet. Thirty feet of pillar

is left between the main entries, and 20 feet between the cross entries. The side pillars are 25 feet wide. The room necks are 9 feet wide and 40 feet long. The rooms are driven on 37-foot centers, 16 feet of which is pillar. The barrier pillars are 50 feet wide. Seventy-five per cent of the mining in this bed is by machine.

The greatest loss of coal is in leaving large stumps after the pillars have been pulled, and by leaving large numbers of solid pillars to prevent squeezes. In many mines this is a big factor because the rooms are driven too wide to support the weight of the overburden. The rooms and headings are not driven on sights in many mines, particularly the smaller ones. The rooms are not driven systematically, and pillars are irregular in size and shape. Some mines have been greatly bothered by squeezes, and have lost large areas of coal.

The Lower Freeport is variable in thickness, and is locally very dirty. In order to compete with adjoining districts, and even with other beds in the same district, operators in the Lower Freeport are often compelled to leave large areas of coal which are slightly below the average thickness of the entire bed, because they cannot produce it at the market price. These areas, of course, are lost, because headings are driven around them and later the pillars are pulled and the abandoned area is cut off from the haulways by the break line.

A large quantity of coal is left on the bottom by machine men. The bottom is inclined to be roly in several localities, and the machine men step-up to avoid these rolls. Some of the larger companies pick up this coal after the machine cutting, but it is not general practice in the district. In other localities from 2 to 4 inches of coal is sometimes left on top to prevent accidents by roof falls, the shale above the coal being very fragile and air-slacking easily.

The loss in handling and preparation is fairly low. The chief loss is due to discarding coal on the gob which sticks to shale and bone binders. The smaller companies have loose endgates on their cars and lose much of the fine sizes which are trampled in the mud and motor sand along the headings. When headings are cleaned the whole mixture is discarded on either an inside or an outside gob.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	0	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	10	5
	30	15

Upper Freeport ("E") Coal.

Distribution and character. This bed, lying about 50 feet above the Lower Freeport and about 190 feet below the Lower Kittanning, is the most important coal in the district. Its thickness is variable but it is exceptionally regular in large areas. The bed averages 3 feet 3 inches thick, and only locally has any partings and binders. It invariably has a regular clay bottom. The roof, where sandstone, is rolly.

The Upper Freeport has been mined extensively on Conemaugh River in Indiana County. It averages less than 2 feet thick at Cramer, but at Seward is 3 feet thick. In many small mines at Lockport it is very irregular, ranging from 3 feet to 6 feet 6 inches thick. A top bench of coal, 2 feet to 2 feet 4 inches thick, carries much pyrite and is separated from the middle bench by 8 to 12 inches of bony coal. The middle bench is excellent coal, 20 to 22 inches thick. A shale parting $\frac{1}{2}$ to $1\frac{1}{2}$ inches thick separates it from a lower bench 20 inches to 2 feet 2 inches thick. The coal in the lower bench is high in ash, but has been used with much success for steaming purposes.

At Robinson and Condit, the coal is 6 to 7 feet thick including a persistent bony top 10 to 12 inches thick, and two bone partings, one averaging 4 inches and the other 6 inches thick. On Black Lick Creek the Upper Freeport coal averages less than 12 inches thick and where 3 feet thick is very bony and extremely high in sulphur. In the western townships it averages 4 feet thick. Openings have been made in the vicinity of Jacksonville, where the coal ranges from 3 feet 6 inches to 4 feet 7 inches thick. It is high in ash and sulphur. In Conemaugh township the coal is 3 feet 11 inches thick, with 3 inches of bony coal and shale 6 inches above the bottom. The Upper Freeport is 5 feet thick on Crooked Creek and its tributaries, including a 6-inch shale parting 18 inches from the top. In Armstrong township the Upper Freeport ranges from 2 to 3 feet thick. New operations are starting in this bed at Shelocta. The coal thins northward and is 2 feet 10 inches to 3 feet 6 inches thick on South Branch of Plum Creek, and is parted by 1 inch of shale 5 inches from the bottom.

The Upper Freeport coal is also very important in the central part of the district. It is mined extensively on Two Lick Creek. At Graceton it is 6 feet 8 inches thick, including an 8-inch shale parting 2 feet 6 inches from the top. The upper bench carries considerable pyrite, and the lower bench is used after washing, for making coke. The coke is bright, hard and has well developed cell structure. On Tearing Run the bed is 6 feet thick, including an 8-inch shale parting 19 inches from the top. A number of openings have been made in the Upper Freeport on Chestnut Ridge, and measurements

show that there is little variation in the thickness of the coal. On the road between Homer and Heshbon, $1\frac{1}{4}$ miles east of Graceton, the coal is 5 feet thick, including 9 inches of shale and bone, 6 to 8 inches from the top. Southeast of Indiana on Two Lick Creek the coal is 7 feet 3 inches thick, including 10 inches of shale 27 inches from the top. This thickness is persistent in most of White township.

The Upper Freeport coal again decreases in thickness northward. On the top of the ridge in the vicinity of the road between Indiana and Greenville, the coal is 4 feet thick, including a 1-inch shale parting 9 inches from the bottom, and another 6 inches thick, 8 inches from the top. It is even thinner near Penn Run, and has two 3-inch shale partings. In the area directly north of Penn Run the Upper Freeport is thin and unimportant. On Dixon and Rayne runs the coal is thin and in large areas is absent.

Recent drilling and studies made by competent engineers indicate that the Upper Freeport coal averages less than 18 inches thick in northern Buffington, Pine, eastern Cherryhill and southern Green townships. The Upper Freeport is 18 inches thick at Nolo. At Pineton and Heilwood it ranges from 12 to 20 inches thick. It is 2 feet 5 inches thick at Mitchells Mills; 2 feet at Cookport; 4 feet 6 inches at Pleasant Valley, but carries a 12-inch bone parting near the top. The coal is thinner at Utah, and the parting is 10 inches thick.

Analysis of the Upper Freeport coal.

	Per Cent	
	Range	Average
Volatile matter	24-34	28
Fixed carbon	55-67	58
Ash	6-11	9
Sulphur	1-3.5	2

It is a stick and block coal, of brilliant lustre, friable, and crumbles when handled. It is an excellent steam coal, and when washed makes good coke. The coal is lumpy when loaded, and is used principally for steam and railroad fuel. The mines were opened about 1900.

The roof is generally hard sandstone, and the bottom either soft fire clay or hard limestone.

Coal losses and mining methods. Practically all of the mines in the Upper Freeport are drift. The prevailing system of mining is room and pillar. The main entries are driven 10 to 12 feet wide, the cross and butt entries 15 feet wide. Thirty-five feet to 40 feet of pillar is left between the main entries, and 15 feet between cross entries. The side pillars are 30 feet wide, and the barrier pillars 50 feet wide. The room necks are 8 feet wide and 40 feet long. The rooms are driven on 35-foot centers, 15 feet of which is pillar. The room break-throughs are 50 feet apart, and 10 feet wide. Six per cent of the entire bed is lost by leaving coal on the top and bottom.

The top coal is left in a few small mines because the operators claim it is slightly inferior, and because it sticks to the roof. Practically all of the mining is by machine and a large quantity of coal is lost on the bottom because the machine men leave from 2 to 18 inches below their cut. In large mines this coal is scrapped, at least partially, but the small operators leave it down. The pillars are pulled in a fairly orderly manner in this bed. The rooms and headings are driven on sights, particularly in larger operations.

The greatest loss in pillar pulling is in allowing rooms to stand too long before retreat work is started. Even after pillar pulling is started idle days result in stumps being lost when the break comes before the mine is operated again. The operators in this district, especially during the war time when maximum production was desired, have tuned off entirely too many rooms before retreat work was started. When the price of coal decreased, pillars between rooms that had been driven could not be recovered because of prohibitive cost. In two mines particularly, visited recently by the writer, large areas of pillars will be squeezed and ridden over if allowed to stand much longer. The timbers are rotting because those parts of the mine which have been temporarily abandoned are not being pumped. Roof falls are starting, and it will be exceedingly dangerous and costly to retimber these old workings in order to recover the pillars. In some mines the pillars are not pulled systematically. Only the easily accessible ones which contain large quantities of thick coal are withdrawn. This causes squeezes in other parts of the mine, which gradually creep over areas containing thousands of tons of good pillar coal. The ultimate recovery of chain, side, and barrier pillars cannot be predicted, because the mines are comparatively new and only a few of these pillars have been drawn. The writer has assumed, however, that 85 per cent of these pillars will be recovered because they appear to be in excellent condition.

The loss in handling and preparation is the average for the district. The principal loss is through loose end-gates and discarding on the gob with impurities. Some of the smaller mines also use the small sizes to ballast track where the bottom is soft.

The Upper Freeport, in general, is very persistent in thickness. However, in some townships the roof and bottom tend to be roly and faults have thinned the coal, preventing profitable mining at present prices. It is doubtful if some of these large areas will be recovered eventually, because other parts of the mine will be worked out and abandoned, and the only way to reach these areas of low coal is by driving new headings or by cleaning up old ones. This is, of course, a very expensive operation, and the value of coal will have to increase enormously before these thin areas are recovered.

The coal in this district is practically untouched. Coal has been cheap until the last few years, and the operators have not realized

the value of the resources. This realization is gradually gaining weight and the operators are now making a very conscientious attempt to attain a larger percentage of recovery. The recovery in this district will probably increase fully 5 per cent in the next five years.

The Upper Freeport coal could be worked in many districts by the longwall method because the roof is ideal in many localities for that system of mining. Operators should not attempt to recover so much coal on advance mining, but should leave at least 50 or 60 percent for retreat mining. Pillar and room sizes would necessarily be changed, increasing the pillar width, and decreasing the width of rooms.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	6	4
In room, entry, and panel pillars	8	2
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roily, thin or dirty areas	4	2
	22	9

Pittsburgh Coal.

Distribution and character. This bed lies about 650 feet above the Upper Freeport. Its occurrence is restricted to the highland on the southeast border of Armstrong County, and the southwest border of Indiana County. The coal is generally clean, but is slaty in some places, and has many partings in others. It ranges from 6 to 10 feet thick, including partings and roof coal. The roof coal is impure and not mined. The lower division of the bed averages 6 feet thick, but the coal is high in sulphur and is slaty. The impurities increase to the southwest.

The bed is 7 feet 2 inches thick at West Lebanon, including a $\frac{1}{2}$ -inch shale parting 2 feet 2 inches from the bottom, and 4 inches of bony coal, 2 feet 2 inches from the top. The coal is 9 feet thick at Iselin, including a 6-inch shale parting 2 feet from the bottom; on Big Run 8 feet thick, including 12 inches of shale 20 inches from the top; on Kiskiminitas River the bed is 6 feet 9 inches thick and carries a $1\frac{1}{2}$ -inch shale parting 2 feet 5 inches above the bottom.

The Pittsburgh coal averages 56 per cent fixed carbon, 33 per cent volatile matter, 8 per cent ash, and 1.5 per cent sulphur. It is a hard stick and block coal, and mines out in fair sized lumps. The first shipping mines in this bed were opened about 1900. The coal is shipped to northern and eastern markets for railroad, steam, and domestic fuel.

The roof of the Pittsburgh coal is hard shale, sandstone, and bone coal; the bottom is soft fire clay and hard sandstone.

Coal losses and mining methods. The system of mining is room and pillar. The main, cross, and butt entries are driven 10 to 12 feet wide. The net pillar width between main and cross entries is 35 feet. The room necks are 10 to 12 feet wide and 18 feet long. The chain pillars are 35 feet wide, and the barrier pillars 50 feet wide. The room break-throughs are 50 to 75 feet apart, and 10 feet wide. The rooms are driven on 27 to 29 foot centers, the rooms being 15 to 17 feet wide. Fully 75 per cent of the mining is by machine. Permissible powder is used.

The greatest loss in the Pittsburgh coal is due to lack of systematic plan of pulling pillars. This bed is inclined to be extremely dirty in small local areas. Operators pull pillars in the best parts of the mine first, allowing the remainder of the pillars to stand until the demand for coal is great and poorer quality can be shipped. This delay causes many of these pillars to be crushed and lost. Many of them have been entirely abandoned after areas have been flooded and the roof in the haulways has caved in. The pillars are not pulled as cleanly as might be because, instead of timbering heavier, large stumps are left to protect machine runners. In some mines rooms and headings are not driven on sights, resulting in the ground hog method of mining. Much coal is left on the roof and bottom. This is inferior in quality, and practically half of it could not be shipped at present day prices. However, much good coal is left on the bottom by machine men. This coal ranges from 2 to 10 inches thick, and is scrapped in very few mines. In some mines the cover is thin and the roof bad, and head coal must be left to hold up the roof. Part of this coal is recovered when pillars are pulled, but large quantities are left in the mine.

The loss in handling and preparation is enormous, due primarily to the excessive impurities in the bed. These impurities, in the form of bone and "sulphur" binders, are stuck to the coal in many areas, and the mines discard large quantities of coal on the gob with these impurities. The rolling stock in several of the mines is very poor, and much coal is lost along the haulways that is later shoveled up and discarded on inside and outside gobs. Some coal is lost because the bed is locally entirely too dirty to separate the impurities from the good coal during times of normal prices. This coal is abandoned and never will be recovered.

Coal losses in Pittsburgh bed.

	Total	Avoidable
On roof and bottom	8	4
In room, entry, and panel pillars	10	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	0	0
In handling and preparation, underground and surface	6	4
In roly, thin or dirty areas	5	2
	29	16

CONCLUSION.

Summary of coal losses in Indiana district.

The Indiana district is now practically all in farming communities with the exception of the coal towns along Black Lick Creek. Until the last few years the miners were chiefly from the farming districts, or from nearby towns, but recently there has been a large influx of foreign labor, bringing with it the usual type of living conditions. The conditions along Black Lick are very poor, mining camps are widely separated, and transportation facilities are not the best. Some of the larger companies now operating in the central and western parts of Indiana County have established well-kept mining towns, with new houses, and adequate supplies of good water. These towns of course, present a barren and unattractive appearance. These companies have also established adequate schools for the younger generation, and also churches and club houses for the moral development and entertainment of their employees.

The district is unionized, with the exception of one or two of the large corporations which operate either on a non-union or open shop basis. The writer was unable to notice wherein labor difficulties affected the percentage of recovery. Strikes have caused idle periods which have an indirect bearing upon the recovery by causing rooms to lie idle and headings to fall in. Squeezes have been induced in some cases, preventing the recovery of certain areas because of prohibitive cost.

The writer chose six mines which fairly represented the entire district both as to production and mining conditions. An intimate study was made of each of these mines as a basis for future calculations. Maps of fifteen other mines were studied in the office. Areas were calculated by a planimeter and the loss checked against the production.

Summary of coal losses in Indiana district.

	Total	Avoidable
On roof and bottom	6	4
In room, entry, and panel pillars	10	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	3
	26	13

CHAPTER XI.

JEFFERSON-ELK DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Jefferson-Elk district is situated in the north central part of Pennsylvania, lies west of the Allegheny Front, and in Jefferson, Elk, and Clearfield counties. All of Elk County is included in the district. Also the following townships of Clearfield County: northern fifth of Lawrence, Huston, Sandy, Union, Brady, Bell, and Burnside; of Jefferson County: Polk, Snyder, Washington, eastern half of Warsaw, Winslow, McCalmont, Henderson, Perry, Young, Bell, and Gaskill; of Indiana County: North Mahoning, Canoe, Banks, East Mahoning, Grant, and Montgomery.

GEOLOGY.

This district lies near the northern edge of the main bituminous coal field of Pennsylvania. All of the Monongahela and the greater part of the Conemaugh group have been eroded. The Allegheny group, the principal coal-bearer, contains the valuable Kittanning and Freeport coals, and is present in practically the entire district.

The Pottsville series, lying below the Allegheny, contains three or more coals, none of which is of commercial value at present. The Pottsville has an irregular outcrop running in a roughly crescent shape along the northern and eastern borders of the district, and marks the boundary of the main bituminous field.

About fourteen coal beds outcrop in this district, five of which produce coal for shipment, two others are mined for farm use, and the rest are either too thin or too impure to be mined profitably at present.

Generalized section of coal beds in Jefferson-Elk District.

Name of bed		Average interval	Range in thickness of coal beds
Allegheny	Mahoning	75	0' — 2' 0"
	Upper Freeport ("E")	45	1' — 6' 0"
	Lower Freeport ("D")	50	1' — 13' 8"
	Upper Kittanning ("C")	50	0' — 3' 0"
	Middle Kittanning ("C")	55	0' — 4' 0"
	Lower Kittanning ("B")	60	0' — 5' 0"
	Clarion ("A")	30	0' — 1' 4"
	Brookville ("A")		0' — 6' 0"
	Mercer		0' — 9' 0"

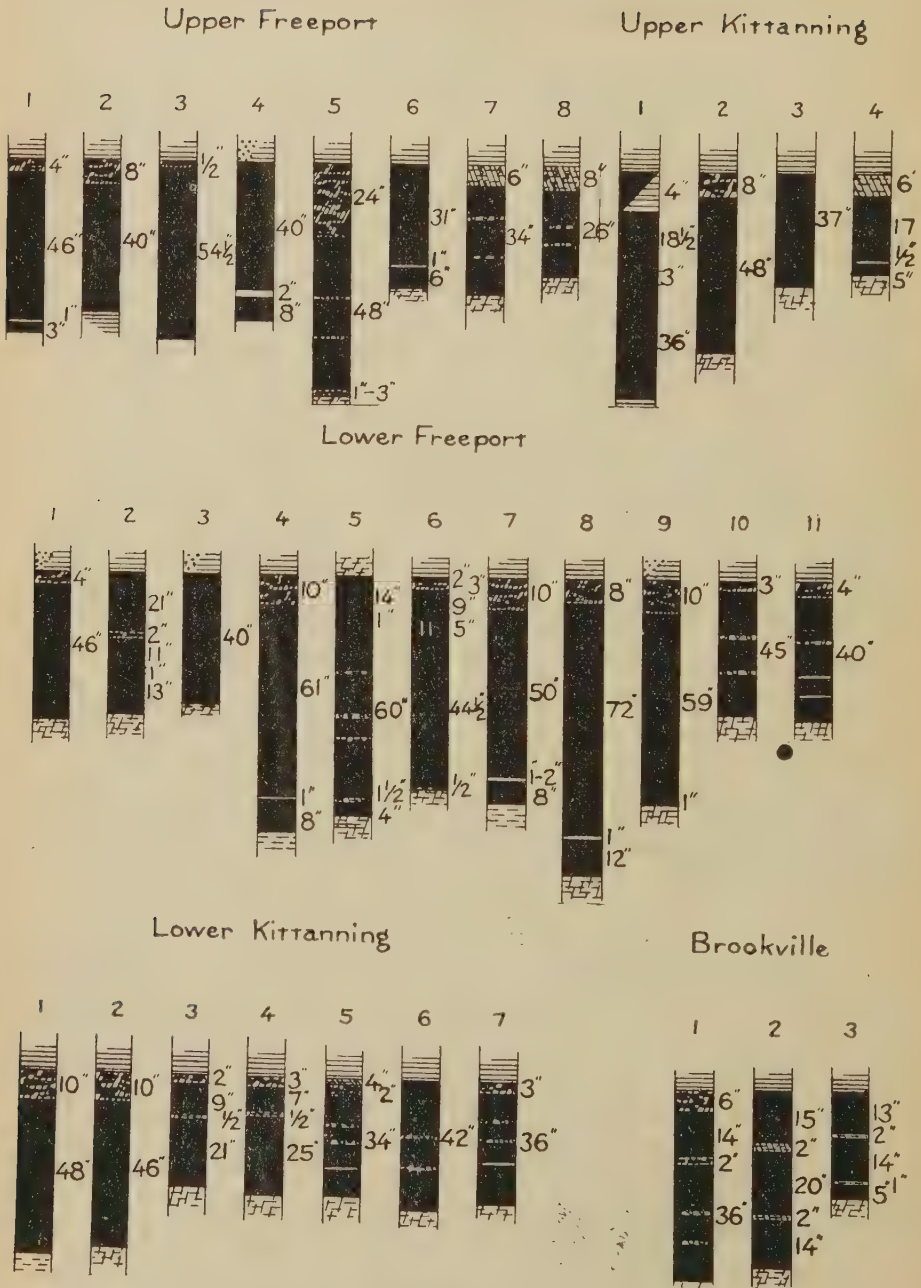


Fig. 19 Sections of coal beds in operating mines in the Jefferson-Elk District, Pa.

DETAILED DISCUSSION BY BEDS

Mercer Coals.

The Mercer coals, in the Pottsville formation, are probably of workable thickness in some areas in the district. They are dirty, and carry numerous shale partings. They have been mined in few places and are used entirely for farm fuel.

Brookville ("A") Coal.

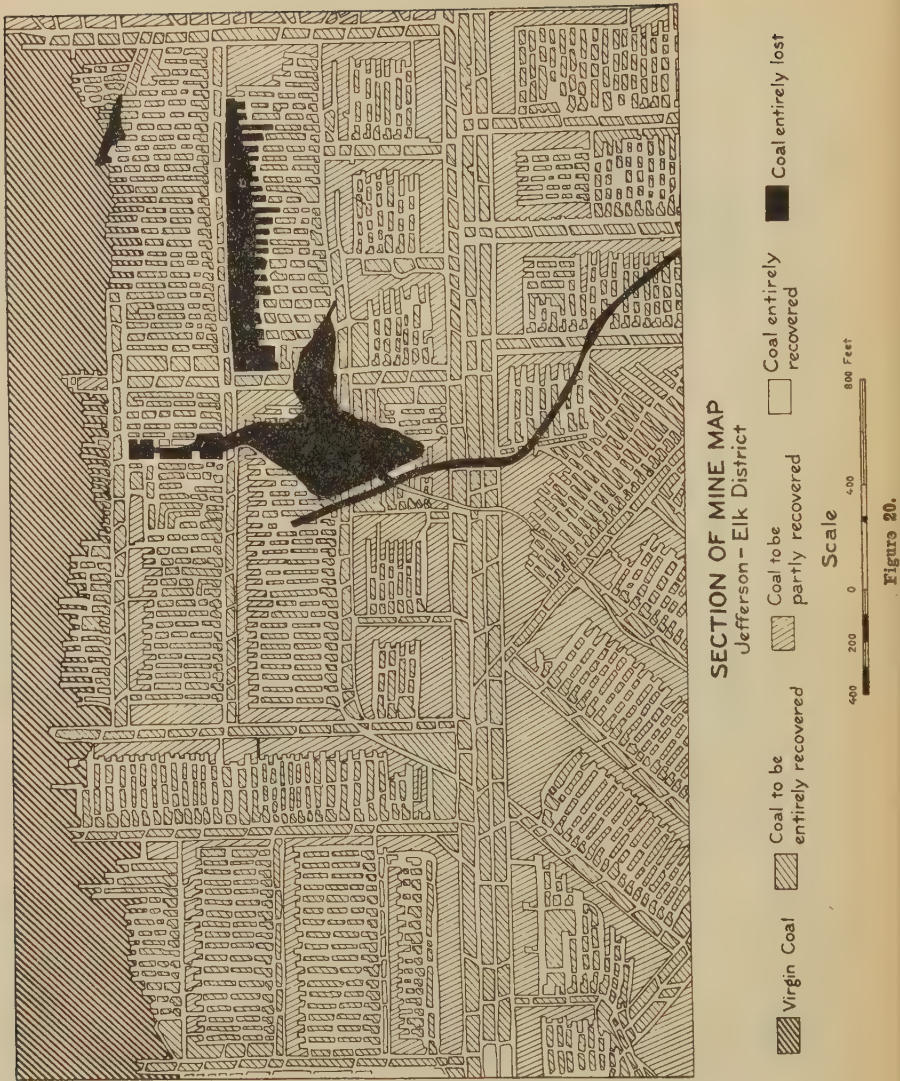
Distribution and character. This coal, at the base of the Allegheny group, ranges from 6 inches to 6 feet thick, averaging about 4 feet. Its physical character varies greatly in short distances. The coal is always very high in sulphur and ash, and the bed carries from one to ten bone and shale partings ranging from one-half to 12 inches thick.

The Brookville coal has been mined extensively in Elk County, where it lies about 80 feet below the Lower Kittanning, and is known as the Clermont coal. It is locally 5 feet 6 inches thick, averaging about 3 feet. The Brookville is deep under cover in most of the southern part of the district and very few mines are opened in it except in the area north of Glen Campbell. Drill records indicate that it is rarely too thin to be mined although it varies greatly in thickness.

The Brookville coal is hard, has uneven fracture, and dull lustre. It varies from 34 to 36 per cent volatile matter, 49 to 53 per cent fixed carbon, 8 to 14 per cent ash, and 2.5 to 7 per cent sulphur. The roof is shale; the bottom, hard fire clay.

Coal losses and mining methods. Mines in the Brookville bed are drift. The mining system is entirely room and pillar. The mines are small and little or no attention has been paid to properly laying them out. The average net width of main entries is 12 feet; of cross and panel entries, 15 feet. The average net pillar width between main entries is 30 feet; between cross entries, 30 feet. The average net width of rooms is 24 feet; of room pillars, 18 feet. Pillar pulling is attempted in these mines, and with care a very large percentage of coal could be extracted. Premature squeezes and heaves cause most of the loss in pillar work. Retreat mining is delayed too long and costly roof falls prevent the removal of large areas of pillars. Too much coal is lost in handling and preparation.

The roadways are not kept clean and much coal is made unmerchantable by mixing with motor sand.



Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	12	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	2
	26	12

Lower Kittanning ("B") Coal.

Distribution and character. This coal, occurring about 90 feet above the Brookville, is the most important and extensively mined coal in the northern part of the district, forming fully 90 per cent of the entire production. It ranges from 2 to 5 feet thick, averaging about 3 feet. It is mined extensively on Bennett Branch in Benezette and Jay townships where it ranges from 2 feet 6 inches to 3 feet 4 inches thick, averaging 2 feet 10 inches. Locally the coal is clean but generally carries many streaks of bone and pyrite. It is 2 feet 10 inches thick at Dents Run; 3 feet 4 inches at Benezette; at Averyville 3 feet 2 inches, including a 6-inch binder of black shale 8 inches from the top; is 3 feet 2 inches thick at Weedville. At Tyler, Force, and Major the coal is persistently 3 feet 4 inches thick, including 4 inches of bony coal at the top.

The Lower Kittanning is mined extensively at Kersey, Dagus, and Toby Mines in Fox township, where it ranges from 2 feet 6 inches to 3 feet 6 inches thick, averaging about 3 feet. It carries a $\frac{1}{4}$ -inch sulphur binder 2 feet above the bottom. Where mined on the Pittsburgh and Shawmut, and Erie railroads in Horton township it ranges from 2 feet 10 inches to 3 feet 2 inches thick. The coal is free from partings and binders but usually carries a few inches of bone at the top.

In Benzingertown township the bed ranges from 2 feet 10 inches to 3 feet 6 inches thick, and is high in sulphur and ash. In Jones, Ridgway, and Spring Creek townships the coal ranges from 2 feet to 3 feet 2 inches thick, is high in sulphur, and roof rolls make mining uncertain.

The Lower Kittanning coal is locally important in the southern part of the district. It has mineable thickness in certain localities in Snyder, Polk, Warsaw, and Winslow townships.

It has a local maximum thickness of 3 feet in the vicinity of Brockwayville, averaging less than 2 feet. In Washington, Winslow, Henderson, Pine Creek, and McCalmont townships the bed seldom exceeds 2 feet 6 inches thick, averaging about 2 feet thick.

The Lower Kittanning is 2 feet 10 inches thick in Perry, Young, Bell, Gaskill, and Henderson townships. It is deep under cover and little is known of its quality and thickness. The Lower Kittanning is exposed in the vicinity of Glen Campbell but is not an important bed at present. It is 3 feet 4 inches thick at Hillsdale; 2 feet 10 inches thick near Arcadia. It varies from 2 feet 8 inches to 4 feet 2 inches at Glen Campbell. Locally it has a $\frac{1}{2}$ -inch bone parting, and a few inches of bone coal at the bottom. The bed varies much in thickness and quality in North Mahoning, Canoe, East Mahoning,

and Grant townships. Little is known of its quality and thickness because it lies deep under cover and has been little prospected.

The Lower Kittanning coal is soft, but makes fair sized lumps when properly mined. It has a bright lustre and imperfect cubical cleavage. It averages about 31 per cent volatile matter, 59 per cent fixed carbon, 7 per cent ash, and 2.5 per cent sulphur. The roof is invariably shale varying in hardness; the bottom is clay of medium hardness.

Coal losses and mining methods. The Lower Kittanning coal is mined by drift, and the mining system is room and pillar. The average net width of main, cross, and panel entries is 11 feet. The average net pillar width between main entries and between cross entries is 35 feet. The rooms are 20 to 25 feet wide, and room pillars from 19 to 22 feet wide.

The recovery is fairly good considering the difficulties under which the coal is mined. Both roof and bottom are locally very roly, causing a large loss of coal. The coal is also locally very dirty and large areas are left when demand is slack and the coal is too inferior to ship.

Very little coal is left on the roof and bottom. The machine men are properly supervised and leave no coal with the exception of step-ups over rolls on the bottom. The recovery in pillar work could be increased by carrying the gob line straight and by not delaying retreat work. The percentage lost in handling and preparation is greater than it should be, because large quantities of coal are lost along the roadways and on the gobs. Coal loaders discard merchantable coal which sticks to the shale.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	2	1
In room, entry, and panel pillars	10	6
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	2
	23	11

Upper Kittanning ("C") Coal.

Distribution and character. The Upper Kittanning coal, lying about 100 feet above the Lower Kittanning, averages about 9 inches thick in the northern part of the district. It is lacking in large areas, and is thin and unimportant in most localities in the central and southern parts of the district. It is deep under cover in most of this area and little is known of its quality and thickness. The

bed is mined along the Pennsylvania railroad in Winslow and Washington townships where it is persistently 2 feet thick, having a local maximum thickness of 3 feet, and carries no distinct partings or binders.

The Upper Kittanning coal commonly has 30 to 35 per cent volatile matter, 52 to 56 per cent fixed carbon, 7 to 11 per cent ash, and 1 to 4 per cent sulphur. The roof is invariably hard shale; the bottom, clay.

Coal losses and mining methods. The bed is mined entirely by drift, by the room and pillar method. Little information on the mining system was obtainable because most of the mines were either idle or abandoned.

The average net width of main, cross, and panel pillars is 10 feet. The average net pillar width between main entries is 35 feet. The average net width of chain pillars is 40 feet. The rooms are generally driven on 45 foot centers, 21 feet of which is pillar.

The recovery percentage is higher than the average of the district because pillars are pulled quite efficiently. The roof is hard and breaks evenly; the bottom is generally very regular. Practically all the loss in pillars is in shells and stumps. Machine men often leave 4 inches of good coal on the bottom, although the average for the bed in the entire district is 2 inches. With proper supervision much loss could be prevented.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	4	2
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	3	1
	20	7

Lower Freeport ("D") Coal.

Distribution and character. The Lower Freeport coal, lying about 50 feet above the Upper Kittanning, is thin and unimportant in the northern part of the district except in the northeastern extension of the Reynoldsville basin in Horton and Fox townships. Here it is 3 feet to 4 feet 6 inches thick, and is generally without partings or binders.

The Lower Freeport coal is the most important bed in the central part of the district. It has been mined extensively for many years at Anita, Adrian, Horatio, Walston, and Punxsutawney in Young township. The coal is 3 to 7 feet thick, including a bony

bench at the top, averaging 4 inches, and local bands of bone and pyrite. In some mines at Walston the coal is 8 feet thick, and free from partings and binders. The bed is 4 feet to 6 feet 6 inches thick in Bell township, and carries no distinct impurities except a bony bench at the top usually not over 4 inches thick. The Upper Freeport coal ranges from 2 feet 6 inches to 6 feet thick in Gaskill township. It is usually free from partings and binders, but locally is split into two benches by an 8-inch shale parting about 12 inches from the bottom.

Probably the greatest thickness of the Lower Freeport coal is in Henderson township, between Big Run and Desire. Here the bed is 13 feet 8 inches thick, including a 2-foot shale parting, 2 feet from the top. At Eleanora it ranges from 3 to 8 feet thick. It is clean where 3 feet thick, but the greater measurement includes a bone parting 1 to 2 inches thick, about 10 inches above the bottom, and 8 inches of bony coal at the top. The Lower Freeport coal is mined extensively at Sykesville, where it is 5 to 6 feet thick, including a bone parting 1 to 2 inches thick, 8 to 10 inches from the bottom.

In McCalmont township the coal ranges from 3 feet to 6 feet 6 inches thick, averaging over 4 feet. A bony parting averaging 2 inches thick, about 2 feet above the bottom, is persistent in extensive areas. A local bone parting about 1½ inches thick is present about 5 inches from the bottom.

The Reynoldsville district, in Winslow township, has been the center of extensive development of the Lower Freeport for many years. Here the bed is extremely variable in physical character. Partings and binders are present in some mines, and lacking in others; in some areas bony benches are present at the top or bottom. The entire bed averages over 5 feet thick, ranging from 4 feet to 8 feet 6 inches.

The Lower Freeport averages over 4 feet thick in Washington township, and has excellent quality. In the vicinity of Falls Creek, it is 5 feet thick, including a 1-inch bone parting 12 inches above the bottom. It has been mined extensively for several years in the vicinity of Coal Glen, where it averages 3 feet 8 inches thick. Locally it has one or more bone partings, and is high in sulphur.

In Snyder township the Lower Freeport coal averages 3 feet 6 inches thick, locally reaching a maximum of 5 feet. It has a characteristic 1-inch bone or clay parting 8 to 12 inches above the bottom.

The Lower Freeport coal is soft and friable, but mines out in good sized lumps. It is a stick and block coal, with alternating bands of bright lustrous and dull coal. It ranges from 28 to 35 per cent volatile matter, 51 to 60 per cent fixed carbon, 4 to 13

per cent ash, and 1 to 5 per cent sulphur. The roof is clay, shale, or sandstone; the bottom invariably is clay.

Coal losses and mining methods. Mines in this bed are opened by drift. The prevailing system of mining is room and pillar. The main, cross, and panel entries range from 20 to 40 feet wide. Chain pillars range from 20 to 40 feet thick. The rooms are driven on 40 or 50 foot centers, the rooms ranging from 24 to 30 feet wide.

This bed has been worked for a great many years and is approaching exhaustion in some localities. A greater percentage of coal has been recovered in these old workings than is characteristic of many old districts in Pennsylvania. Pillar work is favored by a hard, even-breaking roof which stands long after pillars have been removed.

The average loss in pillars is 12 per cent, chiefly in shells and stumps. First mining was not definitely planned; entries were thrown off at the most advantageous point, and room locations were not definitely planned. The cover is usually less than 150 feet and little difficulty is experienced with heaves and squeezes. Fine grade timber is used and the roof in the headings is very well supported by cross bars.

Locally much coal is lost in rolls, the coal thinning down, making mining unprofitable. These areas are abandoned and will undoubtedly be entirely lost. Entirely too much coal is lost in handling and preparation; with careful cleaning of floors in the rooms and by preventing coal from being discarded on the gobs, only 1 or 2 per cent of the entire bed would be lost from this cause.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	9	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	3	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	1
	23	9

Upper Freeport ("E") Coal.

Distribution and character. The Upper Freeport coal, lying about 45 feet above the Lower Freeport, has been much eroded in the northern part of the district and is present only as isolated patches in the hills. It is usually a thick bed, locally measuring 6 feet, but commonly occurring in two 3-foot benches, separated by 6 to 20 feet of shale.

The Upper Freeport is very irregular in thickness and variable in quality in the central part of the district. In some places, however, it is a thick bed of good coal.

The Upper Freeport coal is mined extensively in Washington and Snyder townships at Coal Glen, Brockwayville, and Crenshaw. Here the Lower Freeport is rapidly being worked out, and the Upper Freeport is the next best coal. It averages about 2 feet 6 inches thick, and is fairly clean but high in sulphur.

In Winslow, Henderson, and McCalmont townships the Upper Freeport ranges from 12 inches to 5 feet thick, averaging less than 3 feet. It is impure and locally carries many bands of pyrite. The largest exploitation of this coal in these townships is along Pine Creek. Here the bed averages 4 feet 4 inches thick, including a bony bench at the top, usually about 9 inches thick, and a local parting of bone coal 2 inches thick near the bottom. It is also mined north of Anita in McCalmont township, where it averages 2 feet 8 inches thick, not including a bony bench of variable thickness at the top.

At Anita, in Young township, the Upper Freeport averages 3 feet of good clean coal. It is 3 feet 6 inches thick at Punxsutawney, not including a bony bench at the top, usually 8 inches thick. The bed has a maximum thickness of 6 feet in this township, but invariably carries numerous knife blades of bone and pyrite, making the coal much inferior to the Lower Freeport.

The Upper Freeport averages about 3 feet thick in Bell and Gas-kill townships. Although it has not the good quality of the Lower Freeport, it is mined at many places along the Pennsylvania, and the Buffalo, Rochester & Pittsburgh railroads. Near Hillman it is 2 feet 10 inches thick, including a thin bone parting. In the Big Run area it ranges from 2 feet 8 inches to 4 feet 4 inches thick. Where thickest, a bony bench, 2 inches thick and hard to separate from the coal, occurs about 8 inches above the bottom. It is mined at Onondago, where it averages 4 feet thick, including a 1 to 3 inch bone parting 8 inches from the bottom.

The Upper Freeport coal is persistent and very valuable in the southeastern part of the district. In Grant township, between East and Rairigh runs, the coal ranges from 3 feet to 3 feet 7 inches thick and has 4 to 6 inches of bone coal at the top. East of Mahoning Creek, in Grant and Montgomery townships, the coal ranges from 2 to 5 feet thick. Locally it has a thin bone parting near the bottom, and a few inches of bone coal at the top. The coal averages about 3 feet thick in Banks township. It has a characteristic parting 1 or 2 inches thick a few inches from the bottom, and invariably a few inches of bone coal at the top. It is 5 feet 8 inches

thick at Rossiter, Canoe township, and has a 2-inch shale parting 6 inches from the bottom. South of Rossiter the coal thins to 4 feet, but is clean. At Juneau the coal varies in thickness and locally is rather dirty. A few miles south of Locust the coal is 4 feet 4 inches thick including 4 inches of bone coal at the top.

The Upper Freeport coal ranges from 24 to 34 per cent volatile matter, 55 to 67 per cent fixed carbon, 6 to 11 per cent ash, and 1 to 3.5 per cent sulphur. It is a stick and block coal, of brilliant lustre, friable, and crumbles in handling. It is an excellent steam coal, and when washed makes good coke. The roof is invariably hard shale; the bottom, clay.

Coal losses and mining methods. Mines in this bed are opened by drift. The system of mining is room and pillar. Entries average 11 feet wide; chain pillars are generally 30 feet wide. Rooms are driven on 50-foot centers, and are generally 27 to 30 feet wide.

The percentage of recovery in this bed is higher than any other bed in the district except the Upper Kittanning. Pillars are pulled very clean, the only loss being in pillar stumps. The headings are driven to their full length before any rooms are turned off, and the pillars pulled so that the gob line falls in a straight line at an angle of 45° to the main heading. In certain localities squeezes and creeps are frequent because rooms are gouged out on the sides; in others pillars are not drawn when rooms have reached their limit and are crushed and lost. Machine men leave considerable coal on the bottom. Some coal is also lost in faulty areas. With proper supervision fully 90 per cent of the coal could be recovered from this bed.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	2	1
In room, entry, and panel pillars	9	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	2
	21	9

CONCLUSION.

Coal has been produced in this district for a great many years, principally from the Lower and Upper Freeport beds. Coals at the bottom of the Allegheny group, principally the Brookville and Lower Kittanning, have hardly been touched. They lie deep under cover practically everywhere in the southern part of the district, and are even untested by core drill in large areas. This district is one of the largest reserves of future supply in the State.

Practically all the coal is easily accessible by drift or shallow shaft, and has a ready market as domestic and locomotive fuel. Washing and picking makes the coal very satisfactory for coking.

The horizontal distance between beds in this district is very small. Probably a large amount of coal will be lost in the future by undermining of beds unless proper supervision is given to pillar pulling at the present time. In very few instances, however, are two beds, situated close together, of mineable thickness at one locality. For instance: the Lower Freeport is important in one locality and the Upper Freeport is thin; in another locality the Upper Freeport is thick and the Lower Freeport thin.

No coal lost is directly attributable to miners refusing to perform duties requested of them. Strikes of course cause losses in pillars.

Living conditions in this district are in general very poor. The majority of companies are small with insufficient capital to install modern improvements at their mines, and the workmen must provide for their own welfare. The houses are cheap, cold in the wintertime, and tin roofs make them almost unbearably hot in summer. Nine out of ten mining towns or camps have no sewerage regulations.

Eighteen mines in this district were inspected. Maps and data from forty-three other mines were also studied in detail. •

Summary of coal losses in Jefferson-Elk District.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	10	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	2
	23	10

CHAPTER XII.

CAMBRIA DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Cambria district lies west of Allegheny Mountain, and is the center of the coal industry in the eastern part of the bituminous field. Johnstown is near the center of the district. All of Cambria County is included, with the exception of the following townships: Susquehanna, Barr, Elder, East Carroll, West Carroll, Chest, White, Reade, Clearfield, and Dean. Juniata, Allegheny, and Logan townships of Blair County; and Paint, Shade, and Ogle townships of Somerset County are also included in the district.

GEOLOGY.

Cambria district contains at least 24 coal beds. Five are important, five others are worked locally, and the rest are very thin. The aggregate thickness of all the beds is about 40 feet.

The coal is used chiefly for steaming purposes, being a high-grade smokeless coal in great demand for export.

All of the commercial coal beds are in the Allegheny group, and are easily accessible in practically every township within the district. The Pottsville formation, lying below the Allegheny, outcrops on the eastern edge of the district but is not commercially coal-bearing.

The Conemaugh formation, lying above the Allegheny, also has an extensive outcrop, but its coals are thin and unimportant at present.

The Monongahela group has been entirely eroded in this district,

Generalized section of coal beds in Cambria District.

Name of bed		Average interval	Average thickness of coal beds
Conemaugh 775-900	Coal		1' 9"
		325	
	Coal	165	0' 9"
	Bakerstown	135	0' 6"
	Gallitzin	50	0' 6"
Allegheny 220-375	Mahoning		0' 6"
		50	
	Upper Freeport ("E")	40	3' 6"
	Lower Freeport ("D")	35	2' 6"
	Upper Kittanning ("C")	70	2' 6"
	Middle Kittanning ("C")	20	0' 6"
	Bens Creek	15	1' 0"
	Lower Kittanning ("B")	35	3' 6"
	Clarion ("A")	25	0' 6"
	Brookville ("A")		1' 0"

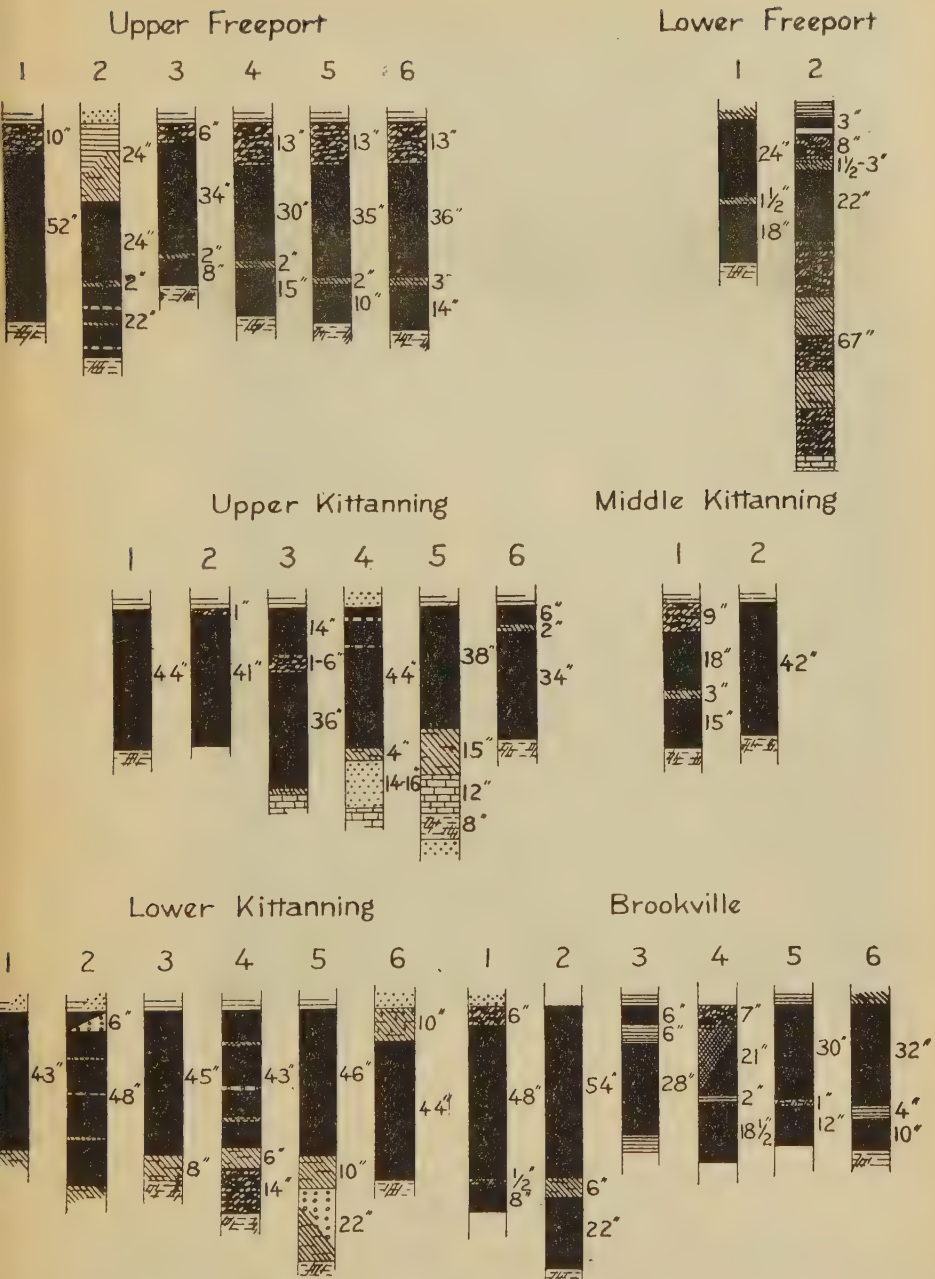


Fig. 21 Sections of coal beds in operating mines in the Cambria District, Pa.

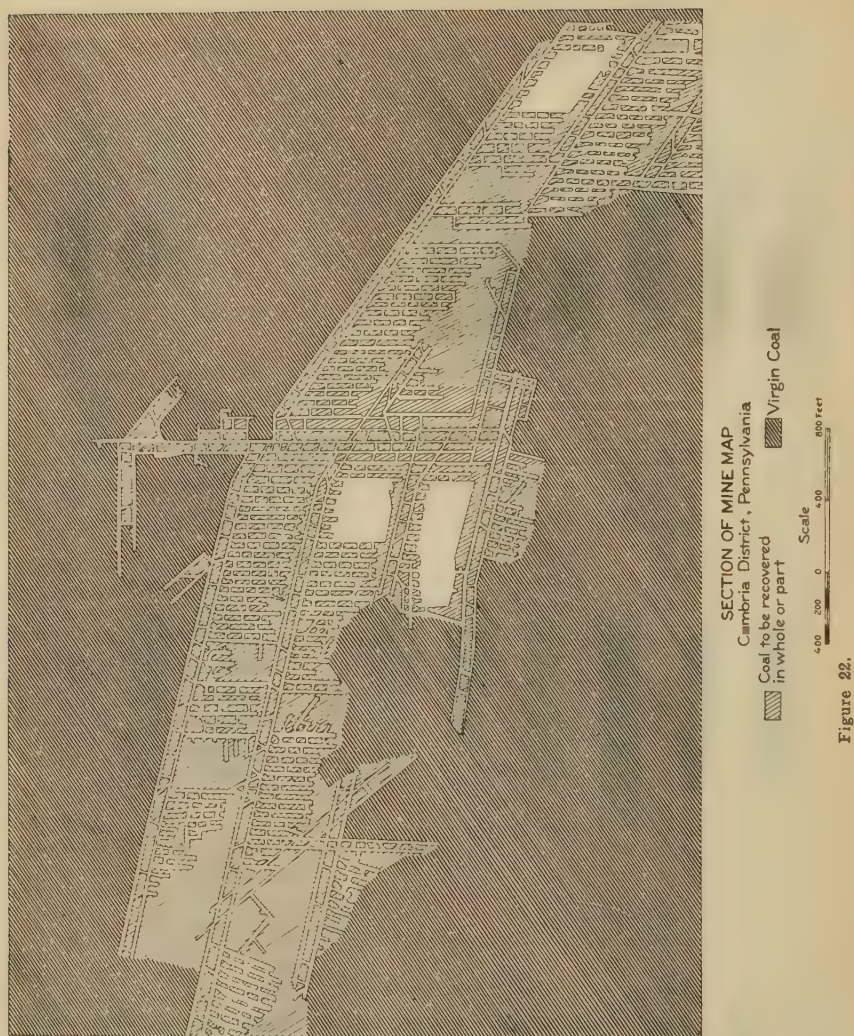


Figure 22.

DETAILED DISCUSSION BY BEDS.

Brookville ("A") Coal.

Distribution and character. The Brookville has few commercial mines in it, the greatest output being from small custom coal mines for local domestic use. The bed has a maximum thickness of 7 feet, but is generally very dirty, and is absent in large areas.

The coal is high in ash and sulphur, but in fixed carbon and volatile matter it compares well with the Lower Kittanning. It is subject to rolls both on roof and bottom, and faults are very common.

Practically all mines in this bed are south of Johnstown along Stony Creek and its tributaries. It is also being mined on the Pennsylvania Railroad east of Gallitzin. In Paint, Shade, and Ogle townships, Somerset County, the bed is usually thick but extremely impure. It has been mined at several localities for local use, but at the present time only one mine is working it for commercial shipments. The Brookville averages about 5 feet thick, ranging from 3 to 7 feet. It is divided into three or four benches by two or three bone partings ranging from 2 to 6 inches thick. The top bench, usually about 6 inches thick, is inferior but is shipped. The middle bench is usually about 19 inches thick, and contains sulphur streaks and nodules. The lower bench, ranging from 2 feet 6 inches to 5 feet 6 inches thick, is separated from the middle bench by a large black shale parting 4 to 6 inches thick. The bottom bench also contains many streaks of sulphur nodules.

Coal losses and mining methods. The mines in this bed are drift and are working the room and pillar system. The net width of rooms is 24 to 28 feet; chain pillars, 30 to 40 feet; room pillars, 20 to 24 feet; barrier pillars, 35 to 50 feet. The net width of entries is 10 to 12 feet.

Operators expect to recover pillars eventually but are delaying the retreat mining, and squeezes are preventing the recovery of large quantities of coal. Entries are allowed to stand too long before retreat work is started, rooms cave, and decayed timbers are crushed by roof falls. Large quantities of coal are lost in handling and preparation, principally because of abundant impurities in the bed. Pillar pulling is not satisfactory because the pillars are too thin to be removed efficiently.

Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	15	10
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	5	2
In roly, thin or dirty areas	10	5
	36	20

Lower Kittanning ("B") Coal.

Distribution and character. This coal is the most persistent bed in the district, contains the greatest coal reserve, and is the largest producer, yielding more than 8,100,000 tons annually. Its development has been slow because it is below drainage in large areas and other good coals are more easily accessible.

The bed averages about 3 feet 6 inches thick, with a maximum thickness of 6 feet, and is locally entirely free from impurities. It varies so much that it has no common physical character in all localities.

The Lower Kittanning is usually split into two or more benches by bone and shale partings ranging from 1 to 12 inches thick. The uppermost benches are usually of excellent quality. The lower bench ranges from 6 inches to 2 feet 10 inches thick, is slightly inferior in quality, and lies below the 10-inch bone parting. The lower bench can not be profitably mined at present prices, and the parting above is used for bottom. One large manufacturing company using its own coal finds that this lower bench, although it can not compete on the market with the upper bench, is a fine steam coal, and has bought enormous tonnages from other companies at a 5 cent royalty per ton.

In the mountain area of this district the bed varies from 1 to 4 feet thick, and is divided into an upper and lower bench by a characteristic binder. Where the lower bench is thick the whole bed is mined and the parting of 2 to 5 inches of bone is picked out before shipment. Where the lower bench is thin the upper bench forms the main part of the bed; the binder is then used as bottom, and the lower bench is not mined. The coal is fairly clean; the sulphur content is low, and ash is medium. The bed is subject to local rolls both on roof and bottom, and to pinches and swamps which cause great variation in thickness.

On Black Lick Creek the Lower Kittanning is the most important bed. It is mined, mainly by drift, from Vintondale, where it first outcrops, eastward to Nanty-Glo and on the tributaries of Black Lick Creek. Enormous areas in Barr, Cambria, and Carroll townships, where the coal is deep, are undeveloped and have been prospected but little by core drill. The worth of this potential coal field is difficult to estimate at present, but it probably contains large acreages of excellent coal. The Lower Kittanning coal closely resembles the same bed on Conemaugh River in its mode of occurrence and physical character. The top or main bench averages from 3 feet 6 inches to 4 feet thick over the entire district. A thin shale parting separates it from a thin middle bench, averaging less than 5 inches thick. The lower bench is separated from the middle bench by a shale parting never exceeding 2 or 3 inches thick. The lower bench has a maximum thickness of 2 feet and averages about 18 inches, is inclined to be high in ash and sulphur, and is not mined unless unusually thick. The top or main bench is a bright and lustrous coal, with columnar cleavage, and mines out in large lumps.

The coal has a very uniform analysis over the entire district. The moisture and volatile matter are low, and fixed carbon averages

around 70 per cent. The ash varies but is low in most analyses. The sulphur content is rather high. Steaming tests made by the United States Geological Survey have shown it to be a high class steam coal. The coal makes a light gray, silvery coke, sometimes soft and high in sulphur. It has been coked successfully in several localities in both beehive and by-product ovens.

The Lower Kittanning is the highest grade, the most important, and most persistent coal in the Johnstown area. Where it is at or below drainage level it is mined by shaft or slope. The Laurel Hill and Ebensburg anticlines bring it to crop at different points along Conemaugh River. The coal lies deep in the Wilmore basin, but in the vicinity of Winber it comes to the surface and is mined by drift.

In the vicinity of Johnstown the coal has a regular thickness of 3 feet 6 inches to 4 feet; the latter is the maximum for the Johnstown basin. A local lower bench 6 to 24 inches thick, which is not mined, is separated from the top bench by 12 inches of shale. The coal in the lower bench rarely has the good quality of the upper bench.

At South Fork and Mineral Point the main bench is thicker than it is at Johnstown, averaging nearly 4 feet, with a maximum of 5 feet. The lower bench has a regular thickness of 2 feet but is seldom mined.

In the Windber region the main bench of the Lower Kittanning coal has practically the same thickness as in the vicinity of Johnstown. In places a rider varying in thickness from 1 to 14 inches occurs 3 feet 6 inches to 4 feet above the main bench; the characteristic lower bench is 3 inches to 2 feet thick.

The Lower Kittanning coal of this area is high in fixed carbon, low in volatile matter and moisture. In the vicinity of Johnstown the bed has a larger percentage of ash and sulphur than in the South Fork area. The fuel ratio also is higher. It is a good steam coal throughout the entire Johnstown region and has been coked with success in a few localities. The yield of coke is large, but is commonly high in sulphur.

In the vicinity of Portage and Gallitzin the Lower Kittanning bed has been the most important for many years. It has high fixed carbon, medium volatile, low moisture, and medium ash and sulphur content. It is in great demand as a high grade locomotive steam coal. In the vicinity of Lilly it is mined and shipped as a smithing coal. It is equal in quality to the Lower Freeport bed of the Friedens district in Somerset County, the standard smithing coal in central Pennsylvania. The bed is a single bench, though locally a thin unmineable lower bench comes in, separated from the main bench by a shale parting about 3 inches thick. The

main bench averages over 3 feet 6 inches thick, with no well defined partings or binders. The bed is very thick, regular, and free from rock rolls.

The Lower Kittanning is a very important coal in Paint, Shade, and Ogle townships, Somerset County. It forms the bulk of production from the well-known Windber district. It is highly prized as a steam, domestic, railroad, and bunker fuel. Thousands of tons are shipped yearly to tidewater and to the Lakes. The coal outcrops well down the hills in the vicinity of Windber, and is mined by drift. The coal can be mined also by drift along Shade Creek and its eastern tributaries, and along the eastern slope of Allegheny Mountain.

The Lower Kittanning is very regular in physical character in the Windber region. The bed is usually divided into two or more benches by thick shale partings. The top bench, which is mined, ranges from 3 feet 3 inches to 5 feet thick. This main and top bench is separated from a middle bench by a band of black and yellow pyrite, and shale, locally known as "blackjack". Underneath the blackjack is a bench of coal which is not persistent, ranging from 2 inches to 2 feet 6 inches thick. This coal is rarely taken up in mining. Locally a second thin bench of coal is present beneath the blackjack.

Coal losses and mining methods. The Lower Kittanning is mined by drift, shaft, and slope, with the room and pillar system. Rooms are generally driven on 50-foot centers, 25 feet of which is in pillar. The net width of main entries is from 12 to 18 feet, averaging 15 feet; the chain pillars are 50 feet wide; barrier pillars, 75 feet; and room pillars, 25 feet.

The total recovery in the Lower Kittanning is 75 per cent.

The lower bench is not mined because of the high cost of removing the parting between it and the main bed. If this bench were mined in the Johnstown basin the average for the district would be very close to 80 per cent.

Much coal is lost because of imperfect engineering methods. Producing headings should be driven to their allotted length, and rooms turned from the back end and worked to the front. Pillars and stumps should be removed as speedily as possible because much coal is lost during idle periods. This method of mining is not practiced because operating companies wish to put the mine on a dividend-paying basis as soon as possible.

Retreat mining is delayed, and in areas where rooms are driven wide the thin pillars are crushed. Rooms are not advanced in proper order, nor are pillars pulled in proper sequence in some mines.

The loss in handling and preparation is also large. Part of this loss could be prevented by more strict supervision of underground preparation, and by keeping the rolling stock in better condition.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	8	6
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	5	2
	25	12

Upper Kittanning ("C") Coal.

Distribution and character. The Upper Kittanning is mined extensively for steam coal in the southern part of Cambria County. It is thickest and best here and development has been rapid in the last few years. The Upper Kittanning is fourth in size of reserve in the district, and ranks second in production with approximately 4,000,000 tons annually.

The Upper Kittanning is important in the mountain area. It has been developed extensively at Daugherty, Lloydsville, and Blandburg. The coal has no characteristic impurities, although locally the bed is split into two benches by a thick bone parting. In such places the coal beneath the parting is not mined. In many localities the coal is overlain with a few inches of draw slate, which is taken down in the rooms and headings for height. The bed varies much in thickness and quality. Its average thickness does not exceed 2 feet 6 inches. The coal does not rank with the Lower Kittanning in quality because iron pyrite makes the sulphur content very high. The ash is medium. Tests have shown that it is a very good steam coal, but is inclined to make large clinkers.

The Upper Kittanning is also important in the Johnstown-South Fork-Windber area. It is best in the vicinity of Johnstown where its reputation as a steam coal is equal to, if not better than, that of the Lower Kittanning. Although its development is of more recent date than the latter bed, the Upper Kittanning coal furnishes a large percentage of the production in this district. Analyses show a high percentage of fixed carbon, and low content of volatile matter and moisture. The percentage of ash and sulphur is rather high.

The Upper Kittanning varies much in thickness in the area around Johnstown. The minimum is 2 feet 6 inches, the maximum 6 feet. The greatest thickness is along Stony Creek and in the Windber area. A local bony coal at the top and local knife blades of pyrite are the only marked impurities.

Along Conemaugh River east of Johnstown the coal is thinner but it has less sulphur and ash than in the Johnstown region.

The Upper Kittanning coal is not mined extensively in the Windber area where the importance of the Lower Kittanning has overshadowed it. Prospecting indicates that the bed will average between 3 and 4 feet thick. It retains its good quality and is marked by the absence of impurities.

The Upper Kittanning bed is not important in the Portage-Gallitzin area. Although the coal compares favorably in composition with the Lower Kittanning, the ash and sulphur content is slightly higher. The mining of this bed is limited and cannot be expected to increase much in the future. The coal shows great variation in thickness and quality. In large areas the bed does not exceed 1 foot in thickness, and averages less than 2 feet. The coal is in one bench.

East of Windber on Paint Creek, and south of Windber on Seese Run, the Upper Kittanning ranges from 3 feet 6 inches to 5 feet thick, averaging 4 feet 6 inches. In these localities the Upper Kittanning is separated into two benches by a bone parting $\frac{1}{2}$ inch to 2 inches thick. The top bench is usually about 2 feet thick, and the bottom bench ranges from 22 to 28 inches thick. A bony coal, ranging from 3 to 6 inches thick, is present at the top of the bed. The roof is shale and sandstone, and the bottom, shale and clay.

The Upper Kittanning has the same physical and chemical character at Arrow, Hagevo, Hillsboro, and Landstreet. It varies much in thickness at different localities, but is invariably separated into two or more benches by thin shale and bone partings. It is of mineable thickness practically everywhere.

In the vicinity of Hollsopple the Upper Kittanning is locally 4 feet thick, averaging 3 feet 4 inches. In many localities in this area it is free from partings. North of Hollsopple at Foustwell and Seanor and east of Stony Creek, the Upper Kittanning averages about 3 feet 6 inches thick, and is divided into two benches by a bone parting from $\frac{1}{4}$ to 1 inch thick, from 3 to 6 inches below the top. The coal above this parting is usually good, but is locally bony and must be separated from the good coal. The bottom bench ranges from 2 feet 4 inches to 3 feet 8 inches thick, and is good clean coal. In some mines this bench has 12 to 18 inches of shale beneath it, and separating it from a bottom bench of coal ranging from 1 to 10 inches thick. This bottom bench is not mined. In some places in this vicinity the Upper Kittanning is rather high in sulphur due to the presence of nodules and streaks of pyrite in the coal. These are readily picked out when the coal is mined.

The Upper Kittanning bed is second to the Lower Kittanning in importance, and has an extensive outcrop in Shade township, Somerset County. In the vicinity of Cairnbrook and Central City, the

principal mining centers in the Upper Kittanning, the bed averages about 3 feet 6 inches, although locally it is 5 feet thick. The bed is entirely clean, with the exception of bone coal at the top ranging from 6 inches to 2 feet thick. Locally the top bench of coal, ranging from 1 to 8 inches thick, is present above this bony coal. The roof is shale and sandstone; the bottom, clay and limestone.

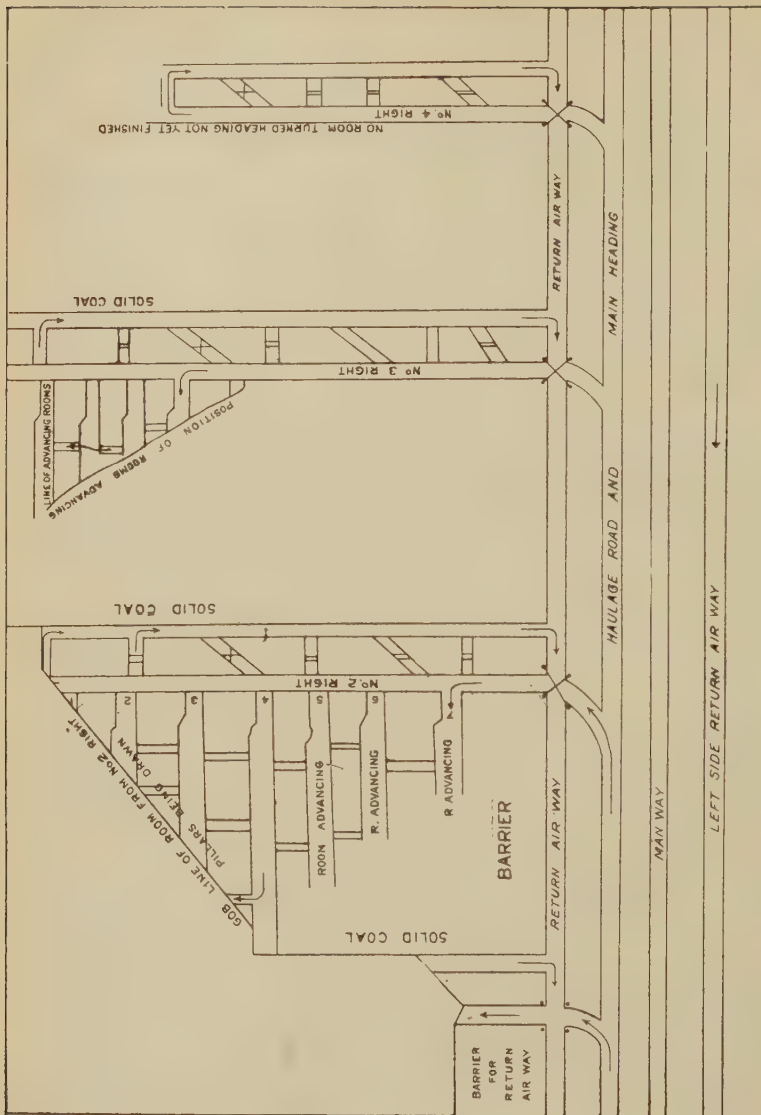
The Upper Kittanning is not being mined on a large commercial scale in Shade township east of Stony Creek. Numerous prospects and small mines indicate that the bed will average about 3 feet 6 inches thick in the western part of Shade township. In most places the coal is clean, but locally it is divided into two or more benches by thin bone and shale partings, and may have 2 to 8 inches of bone coal at the top.

Coal losses and mining methods. Practically all the mines in the Upper Kittanning are drift. The mining method is room and pillar, and is identical to that of the Lower Kittanning. The entries are driven 15 feet wide; the chain pillars are driven 35 feet wide; and the barrier pillars, 75 feet. Rooms are driven on 50-foot centers, 25 feet of which is pillar.

The losses in this bed are due to the same causes outlined under the Lower Kittanning. The largest loss is in handling and preparation, due chiefly to careless picking while loading. Much coal is lost on the gob; coal mixed with sand from the motors is hauled to the dump and discarded. Loose endgates on the cars allow the slack coal to sift through and be trampled in the muddy bottom. Much coal is lost on planes. Coal cars are wrecked and it is cheaper to dump and leave the coal on the spot than to reload it.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	4	4
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roll, thin or dirty areas	6	2
	22	10



SECTION OF MINE MAP
Cambria Co., Penna.

Showing how to bring back pillars against the solid coal of the next panel and prevent heaving of bottom or slumping of top.

Figure 23.

Lower Freeport ("D") Coal.

Distribution and character. This bed is important in the district but not as thick as in the Barnesboro-Patton area in the Clearfield district. In the Johnstown-South Fork-Windber area the bed has not been mined extensively although the analyses compare favorably with those from the Lower Kittanning. The coal has

a high percentage of fixed carbon, low volatile and low moisture content; sulphur and ash are rather high. The bed varies in thickness and has locally a few inches of bony coal at the top. In the immediate vicinity of Johnstown the coal has no commercial importance at present but at South Fork it is locally workable. Here the bed is split into two benches by a thin bone parting. It does not exceed 2 feet 6 inches thick.

South of Johnstown on Stony Creek the bed is persistent and workable, averaging about 2 feet 6 inches thick. It is divided into three benches. A top bench, averaging 12 inches thick, is separated by a shale or bone parting from the main bench averaging 2 feet thick. The lower bench is never mineable.

On Black Lick Creek, and in the mountain area, the Lower Freeport is generally thin and is mined meagerly.

Coal losses and mining methods. The Lower Freeport is mined entirely by drift on the room and pillar system. The average net width of entries is 25 feet; chain pillars are 35 feet wide; room pillars, 25 feet; and barrier pillars, 75 feet. Rooms are driven on 55-foot centers, the rooms being 30 feet wide.

The greatest loss in this bed is from coal left on the roof and bottom. Coal is left up to hold the roof, and bottom coal is left down by machine men after cutting. A large quantity of coal is also lost when room, entry, and panel pillars are pulled. The loss in handling and preparation is medium. Very little coal is lost in roly, thin or dirty areas.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	9	7
In room, entry, and panel pillars	8	2
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	2	0
	23	10

Upper Freeport ("E") Coal.

Distribution and character. The Upper Freeport is one of the most important beds in the district. It is practically of uniform composition with a high percentage of fixed carbon, comparatively low moisture, and a high ash and sulphur content.

In the vicinity of Johnstown the bed averages about 3 feet 5 inches thick. The coal occurs in one main bench. Locally, a lower bench 3 or 4 inches thick is separated from the main bench by 5 to 6 inches of shale or bone; it is never worked. The coal is very

clean, the only extensive impurity being a local draw slate. The bed is regular in thickness although it generally has broad rolls in either roof or bottom. Along Conemaugh River and on the west flank of the Wilmore basin the coal is rather dirty and unimportant, being split by small bone or shale partings into two or three benches. The two lower benches are workable; the upper ranges from 1 to 2 feet and the lower one from 18 inches to 2 feet thick, separated by a bone or shale parting $\frac{1}{2}$ inch to 2 inches thick. The coal is mined at South Fork, where it resembles the same bed at Dunlo, both in thickness and quality. Here the bed is divided into two benches by a thin shale or bone parting which is readily removed by picking.

The Upper Freeport has not been much prospected in the Windber area, but drill records indicate that it averages 3 feet thick. The coal is good in the main bench, as in the Johnstown area.

At the present time there are few openings in the bed because of the greater importance of the Lower Kittanning coal in the same district. Its value is not overlooked, however, and with the depletion of the more valuable coals it will become a larger producer.

The Upper Freeport is one of the most important beds in the Portage-Gallitzin area, and has had an enormous production for many years as a steam and coking coal. As a steam coal it is equal to the Lower Kittanning in the same region except that it is higher in sulphur. The coal has been coked with success in the beehive ovens in the vicinity of Gallitzin. The bed is very regular and averages 4 feet thick in the district; the greatest thickness is 5 feet 1 inch at Gallitzin. At Lilly and Portage the average thickness is 5 feet; in the Puritan area 3 feet 11 inches; and in the Beaverdale Branch area 3 feet 5 inches. The only bone or shale binder rarely exceeds 6 inches in thickness. The bed is free from rock rolls and faults; no clay veins are present.

Coal losses and mining methods. The Upper Freeport is mined principally by drift, on the room and pillar system. The average net width of entries is 18 feet; chain pillars, 30 feet; barrier pillars, 60 feet. Rooms are driven on 50 foot centers, 25 feet of which is in pillar.

The largest loss of coal has been in room, entry, and panel pillars. Retreat mining has been delayed in order to increase production temporarily, and pillars have been squeezed and crushed. Room pillars are entirely too narrow to hold the weight of the overburden.

In some mines gobs are large and are placed against the ribs, interfering with the recovery of the coal. These ribs are often left because they could only be recovered after the gob piles have been removed.

Equipment in some of the mines is in poor condition and much coal is lost in handling. Other mines also lose much coal in car picking. Two to 3 inches of coal is left on the bottom by machine men. In some mines this coal is scrapped but most of the mines leave it down.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	4	2
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	5	1
	21	7

CONCLUSION.

This district is rather thickly populated, and draws much of its labor from the larger towns. However, many large companies have built their own mining town, and provide churches and schoolhouses for the benefit of their workers. Most of these mining towns are kept in good condition, and the houses are modern. The streets in some towns are paved. All of them, however, have tried to beautify their lands by planting trees and grass. These towns present a very barren appearance, especially in winter.

Practically all the mines in this district are union. There are no labor difficulties that affect the recovery of coal other than numerous strikes which cause idle periods. The scale provides for remuneration for the performance of certain labors, and the miners do not refuse to work coal of certain height or remove pillars under certain conditions if they are properly paid.

Limitations of time prevented an exhaustive study of future waste due to undermining of beds. This condition is extremely variable. In some localities, particularly in the vicinity of South Fork and Portage, the loss will probably be very large because the mineable beds are close together.

Much of this loss could be prevented if all pillars were pulled before mines are abandoned. Uneven pillar pulling causes fractures to cut through overlying beds, causing the coal to be crushed and displaced. In these areas timbering will be very difficult and large quantities of coal will be rendered unfit for profitable commercial mining.

Ten mines which fairly represented the district as to mining and coal loss conditions were studied in the field. Maps of twenty-

five other mines were studied in the office and conclusions drawn in reference to coal waste and mining methods.

Summary of coal losses in Cambria district.

	Total	Avoidable
On roof and bottom	7	3
In room, entry, and panel pillars	8	4
In oil and gas pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	5	2
	24	10

CHAPTER XIII

SOMERSET DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Somerset district lies west of Allegheny Mountain and on the southern boundary of the State. All of Somerset County, with the exception of Paint, Shade, and Ogle townships, is included in this district; also Londonderry and Cumberland Valley townships of Bedford County.

GEOLOGY.

This district contains thirty recognizable coal beds, eight of which are mined at present, and four others give promise of future value. The others are generally thin and poor in quality.

Somerset district contains the easternmost remnant of the Pittsburgh and Redstone coals. The Pittsburgh coal was a source of fuel in this district in the early eighties, and is almost exhausted the present workings being confined to the removal of old pillars and crop coal. The Redstone is now being worked extensively in the Berlin-Salisbury basin.

The Conemaugh group has an extensive outcrop in the basins of this district, but contains no coals which are of great commercial value at present. The Bakerstown and Wellersburg coals, averaging about 3 feet thick, will probably have future value. Several other coal beds having a local thickness of 2 feet 6 inches to 3 feet, may be used for local fuel.

The Allegheny group, containing the Brookville, Upper and Lower Kittanning, and Upper and Lower Freeport coals, is the most important coal-bearing group in the district. It outcrops along the flanks of the basins on the slopes of the mountains. Practically all the production of the district comes from the beds in this group.

The Pottsville series, underlying the Allegheny group, does not contain commercial coals in this district.

There are approximately 200 inspected mines, and over 400 small country banks in this district.

Generalized section of coal beds in Somerset District.

		Average interval	Average thickness
Monongahela	Redstone	25	4' 0"
	Pittsburgh (Big Vein)	160	5' 0"
Conemaugh 875'	Lonaconing	155	4' 0" (very dirty)
	Wellersburg	60	1' 0"
	Barton	210	1' 6"
	U. Bakerstown	40	2' 0" (very dirty)
	L. Bakerstown	240	1' 6"
Allegheny 250'	U. Freeport ("E")	50	3' 0"
	L. Freeport ("D")	25	2' 0"
	U. Kittanning ("C")	60	3' 0"
	M. Kittanning ("C")	50	1' 0" (very dirty)
	L. Kittanning ("B")	30	2' 4"
	Clarion ("A")	15	2' 8"
	Brookville ("A")	10	5' 0" (very dirty)
Pottsville 300'	No workable coal		

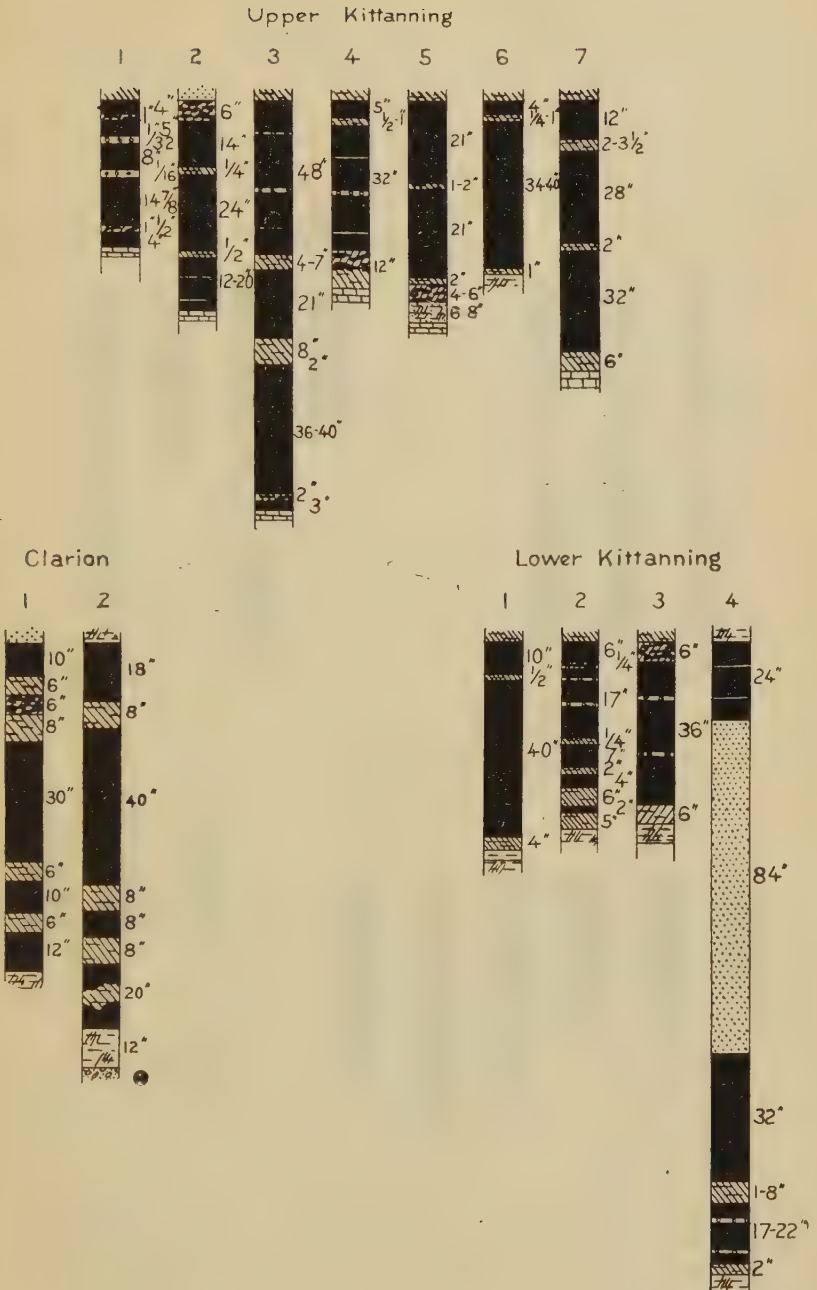


Fig.24 Sections of coal beds in operating mines in the Somerset District, Pa.

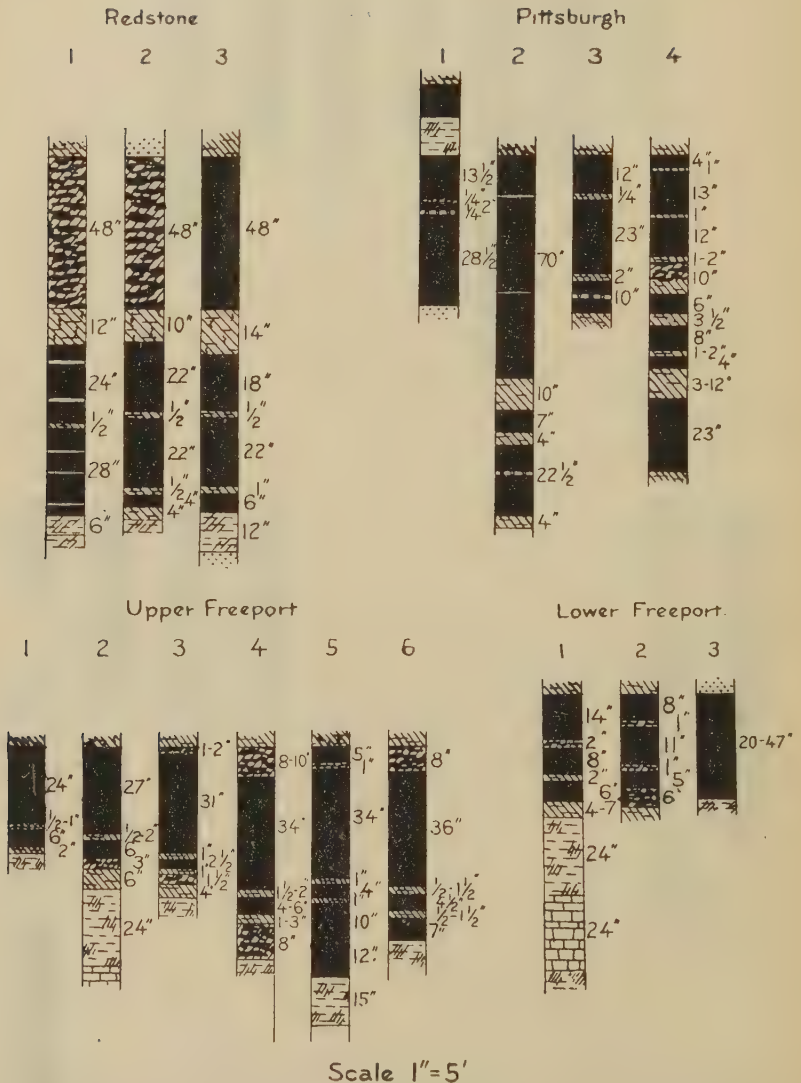


Fig. 25 Sections of coal beds in operating mines in the Somerset District, Pa.

DETAILED DISCUSSION BY BEDS.

Brookville ("A") Coal.

Distribution and character. This bed is thin and extremely impure in Somerset County. It outcrops on the flanks of the basin on Allegheny Mountain and Chestnut Ridge, and on Negro Mountain. It is mined commercially at a few localities, but is extremely high in ash and sulphur. It ranges from 2 to 10 feet thick, and is unimportant except in Black, Brothers Valley, Elk Lick, Milford, Somerset, Conemaugh and Summit townships. The main output is from small custom mines that produce coal in times of high prices, and for local use in farming districts.

Coal losses and mining methods. The mines in this bed are all drift. The mining system is room and pillar. The average net width of main entries is 12 feet. Chain pillars are 35 feet wide, barriers pillars 40 feet. Rooms are driven on 45-foot centers, 20 feet of which is in pillar.

Room, entry, and panel pillars are eventually only partially recovered. Most of this loss is due to roof falls and crushing during idle periods.

No coal is left on the roof, but 2 to 4 inches is left on the bottom because of inferior quality, and machine men fail to cut down to the fire clay bottom.

This bed contains numerous shale partings making the recovery of merchantable parts of the bed difficult. In picking the coal, large quantities are discarded which stick to these shale partings.

The equipment in these small mines is extremely inferior. Much coal is lost which sifts through loose end-gates and rolls off of overloaded mine cars in headings.

Retreat plans are neglected and large areas are lost when the pillars are squeezed and crushed.

Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	4	4
In room, entry, and panel pillars	12	8
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	3	1
In handling and preparation, underground and surface	5	2
In roly, thin or dirty areas	6	2
	30	17

Clarion ("A") Coal.

Distribution and character. The Clarion coal has practically the same physical character as that of the Brookville. Its quality is only fair, the coal being high in ash and sulphur. The bed ranges from 2 to 6 feet thick, and is subject to rolls both on roof and bottom. The principal production is from small country banks.



SECTION OF MINE MAP

Mining losses in Somerset District Pennsylvania

 Virgin Coal
  Coal to be recovered in whole or part
  Coal lost

Scale

500 250 0 500 1000 Feet

Figure 26.

Coal losses and mining methods. All mining in this bed is by the room and pillar system from drifts. The average net width of entries is 12 feet; chain pillars are 50 feet wide; barrier pillars, 40 feet. Rooms are driven on 54-foot centers, 30 feet of which is in pillar.

One of the largest losses is in room, entry, and panel pillars, as practically no pillars are removed. Large quantities of coal are left on the roof and bottom.

Much coal is lost in thin and dirty areas, particularly where mines are driven through rock faults where the coal is thin, making mining unprofitable at present. Miners object to working these thin areas, although the coal is a better quality than in other parts of the mine having greater thickness. In fact, the thinner the bed the better the quality and the fewer the partings.

The loss in handling and preparation is much increased by discarding coal with impurities on the gob. Much of this loss could be prevented by installation of picking tables and washing machinery.

Coal losses in Clarion bed.

	Total	Avoidable
On roof and bottom	10	8
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	5	2
	30	17

Lower Kittanning ("B") Coal.

Distribution and character. The Lower Kittanning coal is unprospected in many parts of Somerset County. Most of the production comes from Conemaugh, Paint, Shade, and Quemahoning townships. Many small mines have been opened in this coal in the southern part of Somerset County but invariably it is thin and subject to rolls both on roof and bottom, and is often "faulted out" by sandstone and shale. In general, mining in this bed is rather hazardous.

The average thickness of the Lower Kittanning in southern Somerset County is probably less than 2 feet 6 inches, although in some places it has a maximum thickness of 5 feet. Locally it is of excellent quality and is highly prized for steaming purposes.

The Lower Kittanning outcrops on Negro and Allegheny mountains in the Berlin-Salisbury basin. It varies much in physical and chemical character, but ranges from a few inches to 5 feet thick.

It is mined by drift at many places along the valley of Coxes Creek, where it averages about 4 feet thick, including impurities. The greater part of the merchantable coal comes from a middle bench ranging from 15 to 18 inches thick. This bench is separated

from the top and bottom benches by $\frac{1}{2}$ -to 2-inch shale partings. An impure bottom bench ranges from 2 inches to 2 feet 4 inches thick. This bench is not mined for shipment but is taken up in rooms and headings for height. The bed is 3 feet thick at Rockwood, including a $\frac{1}{2}$ -inch bone parting in the middle and 6 inches of bone on the bottom. The sulphur streaks and nodules are numerous.

Farther west on Casselman River the bed is remarkably free from impurities and very regular in thickness. East of Casselman it is a double bed separated by a hard fire-clay parting ranging from 2 to 7 inches thick. The top bench is 2 feet 2 inches thick, not including 4 inches of bony coal on the roof. The lower bench is 4 feet 2 inches thick but has two thick bone partings. The lower 6 inches is canneloid.

In Addison township on Whites Creek it is 2 feet 10 inches thick, including numerous partings of bone and pyrite. At Listonburg the bed is single, averaging 4 feet 4 inches thick, but is extremely dirty and high in sulphur, containing many thin shale partings and numerous lenses of pyrite.

The Lower Kittanning in southern Somerset County ranges from 16 to 22.5 per cent volatile matter; 63 to 73 per cent fixed carbon; 6 to 13 per cent ash; and .9 to 3 per cent sulphur. The British thermal units average approximately 13,500.

In northern Somerset County the Lower Kittanning ranges from 2 feet 8 inches to 6 feet thick, averaging about 4 feet. It is an excellent steam coal and is much valued for domestic, railroad, and bunker fuel.

The Lower Kittanning ranges from 3 feet 3 inches to 4 feet 6 inches thick in the vicinity of Windber. The top and main bench is usually about 3 feet 6 inches thick, and is clean coal, with the exception of some pyrite and shale nodules. This bench is separated from a bottom bench by 6 to 12 inches of bottom shale. The lower bench of coal, ranging from 0 to 2 feet 6 inches thick, is usually present, but locally the shale parting thickens and the lower bench is cut out. The roof is sandstone and shale; the bottom, hard fire clay.

In the vicinity of Rummel the Lower Kittanning averages about 4 feet 4 inches thick, ranging from 3 to 5 feet. The main and top bench is usually about 3 feet 6 inches thick, and is separated from a middle bench 2 inches thick, by a 2-inch bony coal parting. The middle bench is separated from a lower 10 inch bench by a shale parting 8 to 10 inches thick. The roof is shale; the bottom, hard clay.

In the vicinity of Hagevo and Arrow the Lower Kittanning is about 4 feet thick. The top and main bench is usually about 3 feet thick, but ranges from 2 feet 6 inches to 4 feet. Locally this bench contains thick layers of black, soft "sulphur," but usually it is clean coal. The top and bottom benches are separated by a shale parting

usually about 12 inches thick. Locally this parting contains pyrite nodules called blackjack. The bottom bench is usually 3 to 8 inches thick. This is mined only when the quality is good. The roof is sandstone and shale; the bottom is clay. Locally a bony coal about 1 inch thick occurs at the top of the bed.

In the vicinity of Blough and Hillsboro the Lower Kittanning is usually about 3 feet thick, ranging from 2 feet 8 inches to 3 feet 6 inches. Two inches of bone at the top of the bed is difficult to separate from the coal. Beneath this bony coal is a bench of good coal, usually about 20 inches thick. This rests on a parting of bone coal and pyrite usually about 12 inches thick. Underneath this blackjack parting is 14 inches of shale and an 8-inch bench of coal. This lower bench is mined when the quality is good. The bottom is shale and clay; the roof, shale and sandstone.

In the vicinity of Landstreet and Seanor east of Stony Creek, the coal averages about 3 feet 4 inches thick, and has the same physical and chemical character as at Blough and Hillsboro. It is divided into two benches by a parting of shale, bone coal and pyrite, ranging from 4 to 16 inches thick. The bottom bench ranges from 4 to 10 inches thick.

In the northern part of Ogle township the Lower Kittanning coal averages about 4 feet thick, and in most places is clean. Locally it is divided into two benches by a thin shale and bone parting near the top. The roof is hard shale, and the bottom clay. Underneath the main bench is a local bench of coal usually about 6 inches thick, and separated from the main bench by an 8-inch parting.

In the southern part of Ogle township the Lower Kittanning is thinner, averaging about 3 feet 2 inches thick. The top coal, usually 5 to 14 inches thick, is bony, and is picked out of the clean coal after shooting. The main bench is 2 feet 4 inches to 2 feet 10 inches thick. The main bench is separated from a bottom bench, usually 4 to 6 inches thick, by a shale parting 3 to 10 inches thick. The bottom, which is roily, is clay and soft sandstone; the roof is shale and sandstone.

The Lower Kittanning is the most important coal mined in Shade township, ranging from 3 to 7½ feet thick. It is never entirely clean, being separated into two or more benches by bone and shale partings. Locally a few inches of coal at the top is bony. The bench usually mined ranges from 2½ to 5 feet thick. The roof is sandstone and shale; the bottom, shale and clay.

In the vicinity of Cairnbrook and Reitz the Lower Kittanning coal ranges from 3 feet 3 inches to 5 feet 10 inches thick. This includes a top bony bench usually present, ranging from 6 to 14 inches thick, which must be picked out of the coal after shooting. The main bench ranges from 2 feet 8 inches to 4 feet thick. It is good coal, but contains numerous thin lenses of pyrite. This bench is the only one mined, and is separated from a lower bench by a shale parting rang-

ing from $\frac{1}{2}$ inch to 12 inches thick. Underneath this parting is a bench of good coal generally about 6 inches thick, but ranging from 2 to 16 inches. Locally a still lower bench of coal about 3 inches thick underlies a shale parting ranging from 2 to 8 inches thick. This bench is never mined.

In the vicinity of Central City, and on the headwaters of Dark Shade Creek the Lower Kittanning varies much in physical character. In the immediate vicinity of Central City the bed is usually about 5 feet thick, including 10 inches of impure top coal that is shipped. Underneath this top coal is 10 inches of bony coal that must be separated by the miners before the coal is loaded. The main bench is usually about 3 feet 4 inches thick, and has good quality. Beneath the main bench is a 4-inch shale parting and a lower bench of coal about 8 inches thick which is not mined. The roof is black shale; the bottom, clay.

East of Cairnbrook along the western slope of Allegheny Mountain, the Lower Kittanning is usually about 4 feet 8 inches thick, including 14 inches of bony coal at the top. Beneath this bony coal is a main bench of good coal usually about $3\frac{1}{2}$ feet thick. This bench contains numerous $\frac{1}{4}$ -inch bone and "sulphur" partings near the bottom. Underneath these partings is a 7-inch bench of good coal. Locally there is an additional bench of coal beneath the latter one, which ranges from 2 to 8 inches thick. This lower bench is not mined. The bottom is clay, and the roof, shale.

South of Central City, and east of Buckstown the Lower Kittanning varies greatly in physical character. It ranges from 5 to 9 feet thick, including impurities. Usually 8 inches at the top of the bed is poor grade, bony coal and is not shipped. Beneath this bony coal is $2\frac{1}{2}$ feet of good coal which carries some pyrite. This coal lies on 12 to 16 inches of bony coal which must be separated from it and from an underlying bench of good coal ranging from 2 feet 4 inches to 4 feet thick. This bench is separated from a bottom bench of coal, usually about 8 inches thick, by 12 inches of shale. The bottom is shale and clay; the roof, shale and sandstone.

In the vicinity of Kantner, Rowena, and Pokeytown the Lower Kittanning coal ranges from 4 to 8 feet thick, including impurities. The top of the bed varies greatly in physical character. In some places the coal is clean up to the roof; in other places a draw slate, ranging from a few inches to 5 feet thick, is present. Locally there is a few inches of bone coal at the top. Beneath the impurities the succession is as follows: Main bench coal, 6 inches to 3 feet 4 inches; shale parting, 4 inches to 4 feet; coal, 4 to 18 inches; shale parting, 2 to 9 inches; coal, few inches to 2 feet. The bottom is clay; the roof, shale and sandstone. In some mines these lower benches are not taken up, and the shale parting below the main bench is used for bottom.

In the vicinity of Hooversville, and along Fallen Timber Run the Lower Kittanning averages 4 feet thick, ranging from 3 to 5 feet. A local top bench of coal, ranging from 1 to 6 inches thick, occurs above a shale and bone coal mixture 4 to 12 inches thick. This bone coal mixture is taken down in the headings for height, and falls when the coal is mined out beneath it. A small bench of coal is lost when mixed with these impurities. Beneath this bone coal mixture is a bench of good coal ranging from 12 to 14 inches thick, and separated from the main bench by a bone parting 1 to 2 inches thick. The main bench of coal is usually between 3 and 4 feet thick, and is clean with the exception of pyrite nodules and streaks. Under the main bench there are locally: a thin shale parting; coal, 6 inches; shale parting, 12 inches; bottom bench coal, 8 to 12 inches. The bottom is shale and clay; the roof, shale and sandstone.

The Lower Kittanning coal outcrops on Allegheny Mountain near the head waters of Boone Creek and Coal Run, and at numerous localities along Stony Creek and its tributaries. It is not being mined on a commercial scale in Stony Creek township, principally because other beds are more easily accessible to railroads. Outcrops indicate that it preserves the same physical character as in Shade township. It will probably average about $3\frac{1}{2}$ feet thick, ranging from 3 to $5\frac{1}{2}$ feet, including impurities. The thick bone coal is present at the top, and one or more small benches of coal occur below the main bench. The main bench is a good grade of coal, but rather high in sulphur because of the presence of pyrite.

The Lower Kittanning coal is not being mined commercially in Somerset township, principally because it is deep under cover in practically the entire area. The writer has reason to believe after examination of many drill hole records that this bed will have future importance when the more easily accessible coals have been exhausted. It ranges from $2\frac{1}{2}$ to 6 feet thick. In some localities it is clean coal; in others it is separated into two or more benches by bone and shale partings 2 to 6 inches thick. The main bench of coal is 2 to 4 feet thick. The bed generally has from 4 to 16 inches of bone coal at the top. The bottom is clay and shale; the roof, sandstone and shale.

The Lower Kittanning bed is not being mined at present on a commercial scale in Lincoln township, because its outcrop is limited to a small area and transportation facilities are bad. The Lower Kittanning will probably average $3\frac{1}{2}$ feet thick in this township, and will be mineable at almost every locality. The writer believes that it will not show the good quality and thickness which it has east of Stony Creek.

The Lower Kittanning bed is mined by drift at several localities on Stony and Wells creeks, where it ranges from 3 to 5 feet thick, including impurities.

In the vicinity of Coleman, Kimmelfton, Mostoller, and Stoystown the entire bed averages 14 feet and has the following section:

Section of Lower Kittanning coal.

Shale, black	
COAL, (containing thin bone partings)	10"
Fire clay, soft	1' 3"
COAL (containing thin bone partings)	2' 0"
Sandstone, soft	5' 0" to 7' 6"
COAL, soft (contains sulphur streaks)	2' 8"
Shale, hard	0' 1" to 0' 8"
COAL, good	1' 4" to 1' 8"
Fire clay, hard	

Opposite Rowena and Hooversville the Lower Kittanning averages 3 feet 4 inches thick, ranging from 3 to 4 feet. The bed contains an average of 7 inches of bony coal at the top which must be separated from the coal after shooting. The main bench of coal is usually about 2 feet thick, and contains numerous thin partings of pyrite. A 20-inch shale parting is underlain by a lower bench of coal 2 to 10 inches thick. The bottom is clay; the roof, shale and hard sandstone.

North of Hooversville, and in the vicinity of Blough and Landstreet, the coal averages 3 feet 3 inches thick, ranging from 3 feet to 4 feet 2 inches. The bony coal is present only locally at the top of the bed, and the main bench below it averages 3 feet thick. The coal in this bench is very free from sulphur, but contains a small number of thin bone streaks. Under this main bench is 3 inches of bony coal that is discarded when mined. This bony coal is separated from a lower bench of coal 1 to 8 inches thick, which is only locally present, by a shale parting ranging from 2 to 10 inches thick. The bottom is shale and clay; the roof, shale.

The Lower Kittanning coal is being mined commercially on the Boswell Branch of the Baltimore and Ohio railroad in the vicinity of Randolph, Boswell, and Critchfield. It averages about 3 feet thick, ranging from 2 feet 6 inches to 3 feet 10 inches thick. It is separated into two or more benches by bone and shale partings.

In the eastern part of Jenner township and on the Boswell anticline, the Lower Kittanning coal averages 3 feet thick. In the vicinity of Randolph it averages 3 feet 2 inches thick, including 6 inches of bony coal at the top.

At Acosta, Jenners, and Boswell the coal averages about 3 feet thick, and is divided into two or more benches by shale or bone partings. The main bench ranges from 2 to 3 feet thick. Above this main bench is a thin bench ranging from 6 to 8 inches, which is usually clean coal but locally bony. It is separated from the main bench by a shale and bone parting $\frac{1}{2}$ inch to 6 inches thick. The main bench is underlain by 4 to 6 inches of bone coal and a local

bottom bench of coal 1 to 5 inches thick. The bottom is sandstone and clay; the roof, sandstone and shale.

Lower Kittanning crops out in the eastern slope of Laurel Hill near the headwaters of Beaverdam and Roaring runs. It is not being worked in this locality at the present, but outcrops indicate that it is of commercial value in some places, ranging from 2 to 4 feet thick. It is separated into two or more benches by bone and shale partings ranging from 1 to 5 inches thick.

The Lower Kittanning bed is one of the most important producers in Conemaugh township. It averages about 4 feet thick, including a shale and bone parting ranging from 1 to 6 inches thick, from 3 to 12 inches above the bottom. The lower bench is not worked. The top bench, containing the commercial coal, averages 3 feet thick and is clean with the exception of lenses of pyrite and bone. Locally one or more thin bone or shale partings are present in the top bench.

In the vicinity of Holsopple and Foustwell the bed averages about 4 feet thick, ranging from 2 feet 6 inches to 5 feet 7 inches. The section of the bed is as follows: Top, bony coal, 2 inches; coal, clean, 18 to 24 inches; bone coal parting, 8 to 14 inches; shale, 12 to 16 inches; coal, 8 inches; bottom, shale and clay.

In the northeast part of the township the Lower Kittanning coal is very regular in physical character, usually being divided into two or more benches by thick shale partings. The top and main bench ranges from 2 to 4 feet thick. The two lower benches usually are very dirty and are not mined. They are separated from the main bench by a blackjack parting ranging from 3 inches to a foot or more thick.

The Lower Kittanning coal is under thick cover west of Stony Creek and is not being mined because other coals are more easily accessible along the creek and close to the railroad. Diamond drill holes indicate that the Lower Kittanning will average between $2\frac{1}{2}$ and $3\frac{1}{2}$ feet thick in areas where it is not being mined.

In northern Somerset County the Lower Kittanning ranges 13 to 18 per cent volatile matter; 68 to 78 per cent fixed carbon; 4.5 to 11.5 per cent ash; .8 to 4.5 per cent sulphur. The British thermal units average approximately 14,000.

Coal losses and mining methods. The system of mining is entirely room and pillar. Most mines are drift mines. Mining is mostly pick, few mining machines being used.

The roof is fair, usually being sandstone or shale, but locally is draw slate, ranging from 2 to 5 inches thick.

The average net width of entries is 12 feet; chain pillars, 60 feet. Rooms are driven on approximately 52-foot centers, 26 feet of which is pillar. The barrier pillars are 50 feet wide.

Unlike mining in the Brookville and Clarion beds, the room, entry, panel, and barrier pillars in the Lower Kittanning are recovered in part, probably because entries are narrow. Most mines have only one entry and are necessarily limited in area because the operations are small. In order to maintain quick and easy production, pillars are rather large and rooms small. After the rooms are driven to the limit of the air supply, retreat operations are begun. A lack of efficient engineering methods in planning future work is apparent in these small mines.

Much coal is lost in a local lower bench which is locally 2 feet thick and slightly inferior in quality. Much coal is also lost in transportation and through failure of miners to properly separate coal from impurities. In the larger mines where proper retreat plans have not been initiated, squeezes have robbed large areas.

Headings should be sufficiently high to allow clearance for well-made cars, and overloading should be strictly prohibited. In many mines the gob is placed in a position which prevents the future removal of valuable chain pillars.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	10	8
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads and streams	1	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	5	3
	26	14

Upper Kittanning ("C") Coal.

Distribution and character. The Upper Kittanning is the most persistent and valuable bed in Somerset district. It contains the largest reserve, and is the largest producer, yielding more than 4,100,000 tons annually. It outcrops in southern Somerset County on the flanks of Allegheny and Negro mountains, and along Casselman River west of Garrett. Where opened at one locality on the western slope of Allegheny Mountain for farm use, it is 2 feet thick and comparatively clean. The bed is mined for shipment in the vicinity of Garrett where it averages 4 feet thick. It is divided into two or more benches by shale partings averaging one-half inch thick. The lower bench, averaging 22 inches, is very poor in quality. This bed has been prospected but little on the eastern slope of Negro Mountain, but outcrop indications are that it may locally be a fairly thick bed of good coal.

The Upper Kittanning coal is one of the most important beds in Buffalo Creek valley northeast of Garrett. Many mines have been producing from this bed for several years, but large reserves still remain. This bed underlies practically the entire county, but is

most easily accessible and of best quality on Buffalo Creek where it ranges from 2 feet 8 inches to 4 feet 2 inches thick, averaging about 3 feet 4 inches. There are no characteristic impurities in the main part of this bed but in most localities a few inches of bone coal are present both on top and bottom. Locally one or more thin bone binders are present. In several localities the coal has been cut out entirely by sandstone faults.

The Upper Kittanning coal crops out in the valleys of Coxes Creek and Casselman River. It has been mined in a few localities. The bed averages from 3 feet 4 inches thick, including numerous shale partings. Locally the bed is divided into two benches by 3 to 4 feet of clay. The upper bench ranges from 12 to 22 inches thick; the lower one from 2 feet 2 inches to 2 feet 8 inches. This clay parting is characteristic in the vicinity of Casselman.

The Upper Kittanning coal, the important coal in Upper and Lower Turkeyfoot townships, ranges from 4 to 9 feet thick, including many impurities. It is characteristically a double bed separated into two benches by a clay or shale parting ranging from 2 to 4 feet thick. Draw slate 4 to 6 inches thick is present at the top of the bed. The upper bench ranges from 16 inches to 2 feet 4 inches thick. Locally it is clean but generally has one or more thin slate partings. The lower bench ranges from 4 inches to 2 feet 8 inches thick, and locally is so dirty that it is mined for height in rooms and headings. The clay parting between the two benches is used for floor in mining the upper bench. At Humbert the Upper Kittanning coal averages 2 feet 10 inches thick. A shale binder from 2 to 4 inches thick is invariably present 2 to 6 inches above the bottom. Except for this one binder the coal is clean. The sulphur content is medium and the ash is low.

The Upper Kittanning coal is mined extensively in the vicinity of Listonburg where it ranges from 3 feet to 4 feet 4 inches thick. The coal is high in sulphur and ash. With the installation of picking tables and washeries, this district would be able to increase its production, ship two grades of coal, and lower the percentage of loss in mining. In this vicinity the physical character of the bed varies greatly in short distances. Where thinnest the bed usually has no characteristic impurities with the exception of small lenses of bone and iron pyrite. Where thickest it is usually divided into benches by one or more thin bone partings, and locally has 4 to 14 inches of bone coal on the bottom. This bone coal is not taken up in mining.

In southern Somerset County the Upper Kittanning ranges from 17.5 to 26 per cent volatile matter; 61.5 to 69 per cent fixed carbon; 8 to 12.5 per cent ash; and 2.5 to 4 per cent sulphur. The British thermal units average approximately 13,500.

The Upper Kittanning is the largest commercial producer in northern Somerset County. Its chief development is in the townships west of Stony Creek, principally Jenner and Conemaugh. It ranges from 2 feet 10 inches to 7 feet 6 inches thick. It is much valued for steam, domestic, and railroad fuel.

The Upper Kittanning bed, lying from 90 to 110 feet above the Lower Kittanning, has an extensive outcrop in Paint township, and can be mined by drift at most places. Although not as large a producer as the Lower Kittanning in this township, this bed has an excellent reputation as a steam and domestic fuel. Large mines are now operating in it.

In the vicinity of Windber the Upper Kittanning coal averages about 5 feet thick, ranging from 3 feet 6 inches to 6 feet. It is never entirely clean, being divided into two or more benches by shale partings. The coal varies much in physical character. Locally 12 inches at the top of the bed is bony coal, and is separated from the bench below by a shale parting not over 2 inches thick. The bench of coal beneath this parting ranges from 2 to 3 feet thick, and is separated from a lower bench by a black bony shale parting, 1 or 2 inches thick. The bottom bench of coal ranges from a few inches to 22 inches thick. The roof is sandstone and shale; the bottom, limestone.

The Upper Kittanning bed is being mined extensively along the eastern bank of Stony and Wells creeks. It ranges from 2 feet 8 inches to 4 feet 6 inches thick, including impurities. In the vicinity of Coleman, Kimmelton, Lambertsville, and Mostoller the bed is divided into numerous benches by shale partings. The top bench of coal ranges from 5 inches to 2 feet 8 inches thick, and is separated from the bench below by a shale parting not over 2 inches thick. The middle bench of coal ranges from 6 inches to 2 feet 8 inches thick. This coal is clean except for streaks and nodules of pyrite. A lower bench, 6 to 10 inches thick, is sometimes present, but is very dirty and is not mined for shipment. The bottom is clay and limestone; the roof, sandstone and shale.

The upper Kittanning bed averages about 4 feet thick, including impurities, in Somerset township. It is mined along the Baltimore and Ohio railroad at Somerset, Listie, and Adams. Elsewhere mining has been delayed because the outcrop is limited to that part of the township lying east of the railroad.

At Somerset the Upper Kittanning averages about 4½ feet thick, including impurities. Two to 4 inches of bony coal forms the top. The main bench ranges from 2 feet 4 inches to 3 feet 8 inches thick. Under it is a clay parting from 2 inches to 2 feet thick. The bottom bench of coal, ranging from 8 to 14 inches, is high in ash and sulphur, but is being mined.

In the vicinity of Listie and Geiger the Lower Kittanning averages $4\frac{1}{2}$ feet thick, including impurities. The top bench of coal ranges from 18 inches to 4 feet thick. This bench contains a few thin partings of bone and sulphur. Below it is a parting ranging from 1 inch to 7 feet thick, which varies much in physical character. In some localities it is soft shale mixed with coal, the bottom being hard shale; in other localities, where the parting is thickest, it is composed of shaly sandstone. The bench of coal lying beneath this parting ranges from 18 inches to 3 feet thick, and is locally dirty and not mined. Then follows 2 to 8 inches of shale, 2 to 5 inches of coal, 2 to 6 inches of shale, and 3 inches of coal.

In the vicinity of Adams and Friedens the Upper Kittanning ranges from $2\frac{1}{2}$ to $4\frac{1}{2}$ feet thick. The top bench, ranging from 18 inches to 3 feet, is good clean coal, and is separated from a bottom bench by a shale parting 1 to 3 inches thick. The bottom bench is usually about 6 inches thick, and too high in sulphur to be mined commercially. The roof is sandstone; the bottom, limestone.

The Upper Kittanning bed is mined by slope near the northern line of Lincoln Township west of Acosta, where it averages 3 feet 8 inches thick. Drill hole records in the Johnstown and Somerset basins, and outcrops along Laurel Hill indicate that this thickness is very persistent throughout the entire township. The bed is never entirely clean, being separated into two or three benches by black shale partings varying much in thickness.

Where mined north of Sipesville and west of Acosta the bed occurs in three benches, as follows: Coal 16 to 24 inches; shale $\frac{1}{4}$ to 3 inches; middle bench 18 to 32 inches; shale 1 to 6 inches; bottom bench 4 to 12 inches. This bottom bench contains many thin shale partings and sulphur streaks, and is not mined for shipment. The bottom is shale and limestone; the top, shale and sandstone.

The Upper Kittanning bed is the most important producer in Quemahoning township. It is being mined on Stony and Quemahoning creeks and their tributaries. It ranges from $2\frac{1}{2}$ to $4\frac{1}{2}$ feet thick, averaging about $3\frac{1}{2}$ feet. It is a coal of excellent quality, and is highly valued for steam, domestic, and railroad fuel.

In the southeastern part of Quemahoning township in the vicinity of Stoystown and Mosteller, the Upper Kittanning coal averages $3\frac{1}{2}$ feet thick, and is divided into two benches by a 2 to 3 inch shale parting. The top bench is usually about 3 feet thick, and is overlain by draw slate 1 to 3 inches thick. The bottom bench ranges from 3 to 8 inches thick, and is usually good clean coal. It is locally underlain by a bench of bony coal averaging about 4 inches thick. The bottom is clay; the roof, sandstone.

In the northern part of Quemahoning township the Upper Kittanning coal ranges from 2 feet 8 inches to 4 feet thick, averaging 3 feet 5 inches thick. The coal generally occurs in one bench and

contains numerous streaks of sulphur. Locally the bed is divided into two benches by a $\frac{1}{4}$ to 4 inch shale parting.

In the southwestern part of Quemahoning township in the vicinity of Ralphton, the Upper Kittanning averages 3 feet 8 inches thick ranging from 3 feet 2 inches to 4 feet thick. The bed is separated into two benches by a $\frac{1}{4}$ to 1 inch shale parting. The top bench is usually about 4 inches thick, and the bottom bench 3 feet 3 inches. The roof is shale and sandstone; the bottom, shale and clay.

In the western part of the township on Twomile and Higgins runs, the coal averages 3 feet thick, including a 3-inch bony bench at the top. The main bench of clean coal ranges from 2 feet 7 inches to 3 feet 6 inches thick. The roof is shale and sandstone; the bottom, shale and limestone.

The Upper Kittanning bed is one of the most important producers in Jenner township, and numerous large commercial mines are working this coal. The bed averages 4 feet thick, and ranges from 3 to $5\frac{1}{2}$ feet thick. It outcrops on Quemahoning Creek and Twomile Run and their tributaries, and on the flanks of the Boswell anticline.

In the vicinity of Acosta the Upper Kittanning averages 3 feet 10 inches thick. It is divided into two benches by a shale binder 1 to 2 inches thick. The top bench ranges from 16 to 22 inches thick, and the bottom bench is usually 2 feet 3 inches thick. The bed is overlain by black shale 3 feet thick. Locally a thin bench of coal is present underneath the lower bench and separated from it by 4 inches of shale. In some mines the coal is divided into three benches by $\frac{1}{4}$ inch partings and has about 6 inches of bone coal at the top. The top bench of coal is usually about 6 inches thick, the middle bench 2 inches, and the bottom bench ranges from 2 feet 6 inches to 3 feet thick. In the vicinity of Critchfield and Ralphton the bed averages 3 feet 8 inches thick, not including 4 inches of bony coal at the top. The main bench is separated from this bony coal by a 4-inch shale parting. The bench ranges from 2 feet 4 inches to 3 feet 8 inches thick. The bottom is shale and limestone; the roof, shale and sandstone.

On the Western Maryland railroad west of Coal Junction the entire bed averages 5 feet 4 inches thick and displays the following section: shale, black; coal 4 inches; coal, bony, 3 inches; coal, dirty, 6 inches; shale 7 inches; coal clean 12 inches; shale and coal 3 inches; coal, clean 1 foot 10 inches to 2 feet 4 inches; shale 2 inches; coal, bony 4 inches; clay and bone coal.

The Upper Kittanning varies much in physical character in the vicinity of Jenners, where it averages 4 feet 3 inches thick. The entire bed is often 6 to 8 feet thick. In some mines the coal occurs in a single bench, with 4 inches of bone coal on top and 5 inches of shaly coal on the bottom. The clean coal averages about 4 feet thick. In other mines the bed is divided into four benches by part-

ings and binders. The usual condition of the bed is: draw slate 4 inches, top bench coal 9 inches, shale parting $\frac{1}{4}$ to 6 inches, main bench coal 4 feet, shale 2 inches, lower bench dirty coal, not mined, 4 to 6 inches. Below this is a $\frac{1}{2}$ -inch shale parting and a bottom bench which also is dirty and not mined.

In the vicinity of Boswell the Upper Kittanning coal averages over 6 feet thick but carries many impurities. The top bench or roof coal, 9 inches thick, is impure and not mined. Under this follow in order: Shale 2 inches; coal, high in sulphur, 12 inches; shale, 2 to 4 inches; clean coal, 2 feet 4 inches; shale, 2 inches; clean coal, 2 feet 8 inches. The bottom is shale and limestone; the top is sandstone and shale.

The Upper Kittanning bed is very important in Conemaugh township. Most of the commercial mines are located along its outcrop west of Stony Creek. It is also mined by slope and shaft at Jerome. The coal increases in thickness south from Johnstown and averages about 4 feet thick, ranging from 3 feet to 5 feet 2 inches. In some localities the bed is clean, but usually it carries a thin bony streak at the top and a few inches of bony coal at the bottom. The roof is shale and sandstone; the bottom shale and limestone. The coal is remarkably uniform and rolls are seldom encountered.

In the vicinity of Holsopple and Foustwell the Upper Kittanning is locally 4 feet thick, averaging approximately 3 feet 6 inches. Locally it is very clean, but usually it is divided into two benches by a $\frac{1}{4}$ to 1-inch bone parting from 3 to 6 inches below the top. The top bench is usually clean, but in some places is bony and must be separated before the coal is shipped. The main bench ranges from 2 feet 4 inches to 3 feet 8 inches thick, and is clean coal. A local bottom bench, ranging from 4 to 12 inches thick, is present below the main bench but is not mined.

The Upper Kittanning is mined extensively in the vicinity of Jerome where it ranges from 4 to 5 feet thick. The average section is as follows: Shale roof; coal, bony, 10 inches; coal, clean, 2 feet 6 inches; "sulphur" and bone, 2 to 12 inches; coal, clean, 1 foot 6 inches to 4 feet; shale, 1 to 3 inches; coal, dirty (not mined), 6 to 10 inches; shale and limestone.

The Upper Kittanning coal has a columnar structure, is of medium hardness and stands shipment well. Locally it is rather high in sulphur and ash, but in general it is a good low-volatile coal.

In northern Somerset County the Upper Kittanning ranges from 12 to 17.5 per cent volatile matter; 69 to 77.5 per cent fixed carbon; 6.3 to 11.5 per cent ash; .7 to 3 per cent sulphur. The British thermal units average approximately 14,000.

Coal losses and mining methods. The Upper Kittanning is mined almost exclusively by drift. A few shafts and slopes are located in the northern part of Somerset County.

The room and pillar method of mining is used entirely. The average net width of entries is 12 feet; chain pillars, 40 feet. Rooms are driven on 55-foot centers, 25 feet of which is pillar. Barrier pillars are 40 feet wide.

The greatest avoidable loss of coal in this bed is in leaving coal on the roof and bottom. Small mines leave a maximum of 12 to 14 inches of coal on top to hold up the roof in order to minimize timbering costs. Large mines also have roof trouble and leave several inches on top. This coal is recovered only in part. Large quantities of coal are also left on the bottom in machine mines. Small mines also leave several inches for solid bottom on which to lay track. In the vicinity of Jenner the bottom coal is inferior and is left in the mines.

The next largest loss is in room, entry, and panel pillars. Rooms are driven their allotted length and allowed to stand idle. Too many rooms are driven off headings when demand is strong and a large number of working places is desired. These rooms stand idle, timbers rot, and the pillars are crushed. Large areas are cut off the haulageways by roof falls which are too large to be cleaned up and the coal behind can not be profitably recovered. Pillars are too narrow and are often crushed by thick overburden. Main headings are often exposed to heavy side shearing in mines working under thick cover because side headings are not driven in advance on each side of the main heading. Too much coal is taken out on advance work. Pillars are too narrow and rooms too wide.

Large quantities of coal are unavoidably lost in roly, thin and dirty areas. Although the coal in these areas has excellent quality it cannot be profitably mined at present prices. The only alternative is to abandon it because workings must be extended to areas containing merchantable coal.

The loss in handling and preparation is small. Equipment is in excellent condition and the headings and rooms are cleaned of all loose coal. There is some loss from discarding coal with impurities and in small mines by blowing coal on the gob when shooting from the solid.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	10	8
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads and streams	1	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	5	2
	26	13

Lower Freeport ("D") Coal.

Distribution and character. The Lower Freeport is thin practically everywhere in Somerset district, averaging less than 3 feet. It is mined locally where it has exceptionally good quality and thickness. Although the bed is very irregular in thickness it is very high grade, and in the vicinity of Friedens is a fine smithing coal. It is fourth in size of reserve within the district, and ranks sixth in production yielding approximately 175,000 tons annually.

The Lower Freeport outcrops on Negro and Allegheny mountains but is opened only for local use. On Buffalo Creek it ranges from 22 inches to 3 feet 2 inches thick, and contains one or more local bone partings. The bed is very lenticular and is subject to rolls on roof and bottom which make the thickness very irregular. The coal is high in ash and sulphur.

The Lower Freeport coal crops out on the hills on the eastern bank of Coke's Creek, and on Casselman River southwest of Rockwood the bed averages about 2 feet 6 inches thick. The top bench, which is 21 inches thick, is fairly clean and is separated from an impure bottom bench by a bone and shale parting averaging 18 inches thick. The bottom bench is rarely loaded for shipment.

The Lower Freeport coal is mined on Cox's Creek north of Rockwood, where it averages 3 feet 6 inches thick. A bone parting ranging from 7 to 14 inches thick separates the bed into two benches. The top bench averages 2 feet 3 inches thick, and the lower one ranges from 8 to 20 inches. Locally there is another thin bench of coal on the bottom ranging from 2 to 6 inches thick. This bench is not mined.

The Lower Freeport is thickest in Somerset and Quemahoning townships in northern Somerset County. It ranges from 2 to 4 feet thick, averaging 3 feet. Rolls on the floor are numerous, and the quality is variable. In some localities it is an excellent smithing coal, in others a steam coal.

The Lower Freeport coal outcrops east of Wells and Stony creeks in a general northeast-southwest line running half a mile west of Shankville and Boone. The only commercial mines in this bed are in the vicinity of Stoystown, where the bed ranges from 2 to 3½ feet thick, averaging about 3 feet. Locally the bed is divided into two benches by a shale parting ¼ inch thick or less. The top bench is usually about 18 inches, and the bottom bench from 4 to 10 inches thick. In other localities, where the bed is divided into three benches by shale partings 1 to 2 inches thick, the top bench is usually about 2 feet 1 inch, and the middle and bottom benches are 6 to 10 inches thick. The bottom is limestone and clay; the roof, shale and sandstone.

The Lower Freeport bed outcrops east of Somerset on the Bedford pike, and along Wells Creek in the vicinity of Listie, Wells Creek, and Friedens. It has been mined for several years in the vicinity of Friedens, and is highly prized as a smithing coal. It has also been mined at a great number of places for local use where the thickness ranges from 2 feet 6 inches to 4 feet 2 inches. The bed usually occurs as a single bench of clean coal.

In the vicinity of Listie and Adams the bed averages $3\frac{1}{2}$ feet of clean coal. It has a single persistent $\frac{1}{16}$ inch parting near the middle. The roof is shale; the bottom, clay.

In the vicinity of Friendens the bed is a single bench averaging 2 feet 9 inches thick. The roof is gray shale; the bottom, hard clay.

The Lower Freeport bed is persistent in Lincoln township, but appears to be subject to great irregularity in thickness. Drill hole records indicate that it is of mineable thickness in some localities where it occurs in a single bench, ranging from 18 inches to 3 feet 2 inches thick. It outcrops on the eastern slope of Laurel Hill and ranges from 6 inches to 4 feet 3 inches thick.

The Lower Freeport coal is not being mined in Jenner township because its thickness and quality do not compare favorably with nearby beds. This bed is subject to great irregularity in thickness and quality, ranging from a few inches to 4 feet thick. Locally it is a high ash and sulphur coal but has an excellent reputation in an adjoining township as a smithing coal. It has been prospected at many places in the township, and is practically everywhere separated into two or more benches by shale and bone partings. Bony coal 2 to 8 inches thick is present at the top of the bed.

The Lower Freeport coal outcrops along Stony Creek, but is not being mined at present because of the proximity of thicker beds. It ranges from a few inches to 4 feet thick, averaging less than $2\frac{1}{2}$ feet. It is usually clean, but locally is split into two or more benches by bone and pyrite partings ranging from 2 to 10 inches thick.

Coal losses and mining methods. All the mines in this bed are small drifts, and are worked only in times of excessive demand.

The method of mining is entirely room and pillar. Entries are 12 feet wide. The net width of chain pillars is 40 feet. Rooms are driven on 45-foot centers, 25 feet of which is pillar. Barrier pillars are 50 feet wide.

The mining methods in this bed are very inferior, and much coal is wasted particularly on the roof and bottom. Roof coal is left up to minimize timbering, and bottom coal left down to make a solid base for track laying. In many areas from 2 to 10 inches are left on the bottom because the coal contains many "sulphur" balls.

Pillar pulling is attempted with little success, practically all the loss being from pillars standing idle during slack times or strike periods. The extreme irregularity of the bed causes much loss where miners refuse to work coal under certain height. These thin areas are bratticed off and are eventually lost by flooding or squeezes.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	10	8
In room, entry, and panel pillars	5	0
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface ...	2	0
In roly, thin or dirty areas	10	5
	29	13

Upper Freeport ("E") Coal.

Distribution and character. The Upper Freeport coal has an extensive outcrop in the district. In northern Somerset County its largest development is in Jenner, Conemaugh, Lincoln, Somerset, and Quemahoning townships where it ranges from 2 feet 10 inches to 5 feet 11 inches thick. It is third in size of reserve, and ranks third in production with over 840,000 tons annually. In southern Somerset County the Upper Freeport outcrops halfway up the slope of Negro and Savage mountains, and is being mined by drift. This bed gives more promise of future value than any other coal in the Allegheny group. It averages 3 feet thick in Elk Lick township. The largest production comes from the vicinity of Engle's Mills and Boynton where 3 feet is the common thickness. The physical character of the bed varies greatly in short distances. However, there are always two or more shale partings varying from 1 to 14 inches thick. The coal is soft and friable but is excellent for steaming purposes. This bed has also been opened by farmers for domestic use on the eastern slope of Negro Mountain. On the headwaters of Tub Mill Run it is 2 feet 4 inches thick and has excellent quality, but as this region is practically uninhabited and little prospecting has been done, it is not known whether this thickness and quality is general.

The Upper Freeport coal outcrops and is mined by drift high on the hills on the eastern slope of Coxe's Creek and on Casselman River southwest of Rockwood. The bed varies much in thickness and quality locally, and has no characteristic impurities with the exception of small lenses of pyrite. The bed varies from 2 feet 4 inches to 3 feet 8 inches thick in the Coxe's Creek valley. A top bench ranging from 18 inches to 2 feet 6 inches thick is fairly good coal. Below this main bench are several smaller benches of coal alternating with thick bone binders. This bottom coal is not mined. The coal is thickest under a shale roof.

In southern Somerset County the Upper Freeport ranges from 18 to 21 per cent volatile matter; 65 to 68 per cent fixed carbon; 8 to 12 per cent ash; and 1 to 3.5 per cent sulphur. The British thermal units average about 13,500.

The Upper Freeport is being mined commercially east of Mostollar in Stony Creek township where it averages about 5 feet thick, including impurities. A draw slate about 6 inches thick is present at the top. The bed is divided into four benches of coal as follows: Top bench coal 6 inches; bone coal 1 inch; main bench clean coal 2 to 3 feet; shale 1 inch; coal 4 inches; shale 1 inch; coal 10 inches; canneloid coal 12 inches. The bottom is clay; the roof, sandstone.

The Upper Freeport coal is mined in several places in Stony Creek township by farmers for local use. It varies much in thickness and quality, and is never clean. It is doubtful whether this coal will have the great future importance which the Upper and Lower Kittanings undoubtedly will enjoy.

The Upper Freeport bed is the most extensively mined coal in Somerset township, probably because it is the most easily accessible. It ranges from 2 feet 8 inches to 3 feet 10 inches thick, averaging 3 feet 6 inches. It is always separated into two or more benches by shale partings which vary much in thickness at different localities.

In the vicinity of Somerset the bed is generally 3 feet 5 inches thick; including impurities. A bone coal, usually about 6 inches thick, is present at the top of the bed. The divisions below the bone coal are as follows: Main bench of clean coal, 2 to 3 feet thick; shale parting $\frac{1}{2}$ to 2 inches; coal 3 to 6 inches; shale parting 1 inch; bony coal 2 inches.

Along the Baltimore and Ohio railroad between Somerset and Geiger the Upper Freeport coal averages 3 feet thick, including impurities. The bed contains 1 or 2 inches of bony coal at the top; a main bench underneath 2 feet 7 inches thick; parting 1 inch; coal 2 $\frac{1}{2}$ inches; shale parting 1 inch; dirty coal 1 $\frac{1}{2}$ inches.

Between Geiger and Friedens, particularly in the vicinity of Listie, the coal averages 3 $\frac{1}{2}$ feet thick. The bed usually has 4 to 6 inches of bony coal at the top. The main bench is usually 2 feet 8 inches thick, and is separated from a middle bench 4 inches thick, by a shale parting 1 inch to 1 $\frac{1}{2}$ inches thick. The middle bench is separated from an impure bottom bench usually about 4 inches thick, by a shale parting not over 1 inch thick. The bottom is fire clay; the roof, shale.

The greatest production in Lincoln township comes from the Upper Freeport bed. It is mined extensively by drift in the vicinity of Sipesville and Acosta. It averages about 3 feet 8 inches thick in the township, ranging from 3 to 5 feet. The bed is separated into three benches by shale partings. Drill hole records and outcrops at

points where it is not now being mined indicate that the coal is very regular in thickness and is of mineable quality practically everywhere.

In the northern part of this township, where the bed is now being mined extensively, it is usually divided into three benches. The section from the top down is: Bony coal 4 to 10 inches; top bench coal 22 to 38 inches; shale parting $\frac{1}{2}$ to 2 inches; middle bench 4 to 8 inches; shale parting $\frac{1}{2}$ to 3 inches; bottom bench 4 to 10 inches. The bottom bench is usually clean, but locally contains numerous small knife blades of bone and pyrite. The bottom is clay; the roof, sandstone.

The Upper Freeport coal is mined commercially on the Boswell Branch of the Baltimore and Ohio railroad in the western part of Quemahoning township. It averages 3 feet 4 inches thick, and is extremely impure in some localities. The main bench ranges from 2 $\frac{1}{2}$ to 3 feet thick, and is overlain by a bony bench 3 to 8 inches thick. It is separated from a bottom bench 3 inches thick of variable quality, by a 1 to 2 inch shale parting. This bench is separated from a lower bench of dirty coal, by a shale parting 1 inch thick.

On Stony Creek the Upper Freeport varies much in physical character, but is of mineable thickness at most localities. It is always divided into two or more benches by shale and bone partings, the main bench ranging from 2 to 3 $\frac{1}{2}$ feet thick. From 2 to 8 inches of bony coal is always present at the top of the bed. The roof is sandstone and shale; the bottom, fire clay and shale.

The Upper Freeport coal is very important in Jenner township, where it is mined by drift, shaft, and slope along the Baltimore and Ohio and Western Maryland railroads. The coal outcrops along Quemahoning Creek and its tributaries, on the east and west slopes of the Boswell anticline, and along the eastern slope of Laurel Hill on the headwaters of the Beaverdam Run and North Branch of Quemahoning Creek. It averages 4 feet thick throughout the township, ranging from 3 to 5 feet. This coal enjoys an excellent reputation as a steam, domestic, and railroad fuel.

In the vicinity of Acosta the bed averages 3 feet 10 inches thick. It includes a bony coal at the top, a main bench of coal 2 feet 6 inches to 3 feet 10 inches thick, shale parting 1 to 2 inches, middle bench 4 to 6 inches, shale parting $\frac{1}{4}$ to 1 inch, lower bench 7 to 8 inches. The bottom is clay; the roof, shale.

In the vicinity of Critchfield and Ralphon the coal averages 3 feet 11 inches thick, but is not being mined extensively at present. A bony coal bench 6 inches thick is present at the top of the bed. Shale partings $\frac{1}{2}$ to 2 inches thick separate the bed into a main bench of clean coal 2 feet 8 inches to 3 feet 4 inches thick, middle bench 4 $\frac{1}{2}$ inches thick, and a bottom bench, present locally, 2 to 4 inches thick. The bottom is clay; the roof, shale.

In the vicinity of Coal Junction and on the Western Maryland railroad the Upper Freeport averages 4 feet thick. The characteristic 8-inch bony coal overlies the following section: main bench clean coal 3 feet; shale, $\frac{1}{2}$ to $1\frac{1}{2}$ inches; middle bench, $4\frac{1}{2}$ inches; shale, 1 to 3 inches; lower bench, dirty, and sulphurous, 7 inches. The bottom is clay; the roof, sandstone.

The bed along the Western Maryland railroad varies much in physical character, often being separated into several benches by 1 to 4 inch shale partings. A main bench of clean coal ranging from 2 feet 8 inches to 3 feet 10 inches thick is always present.

In the northern part of the township, in the vicinity of Boswell, the Upper Freeport coal averages 3 feet 8 inches thick. Six inches at the top is bony. The bed is divided by 1-inch shale partings into a main bench of clean coal 3 feet thick, a middle bench 3 inches thick, and a lower bench 4 inches thick. The bottom is shale and clay; the roof sandstone.

The Upper Freeport bed, outcropping on Stony Creek and on the South Fork of Bens Creek near Thomas Mills, is not an important producer at present. It is being mined at one locality on Stony Creek where it averages 2 feet thick. It is inclined to be faulty and rolly, and usually carries large amounts of bone and pyrite. Drill hole records west of Stony Creek indicate that it is of mineable thickness in many localities, ranging from 2 to $4\frac{1}{2}$ feet thick.

The Upper Freeport in northern Somerset County ranges approximately 17 to 21 per cent volatile matter; 64.5 to 67 per cent fixed carbon; 10 to 15 per cent ash; 1.5 to 2.5 per cent sulphur.

Coal losses and mining methods. The large mines in this bed use the room and pillar system of mining. The small mines employ no system. Much coal is lost through ground-hogging.

The net width of entries is 12 feet; chain pillars, 40 feet. Rooms are driven on 40-foot centers, 20 feet of which is in room pillar. Barrier pillars are 75 feet wide.

The greatest avoidable loss of coal is on the roof and bottom. Several inches are left in most mines to hold up the roof, and machine men leave from 1 to 5 inches of coal on the bottom below the cut. This coal is not recovered on the retreat.

Pillars are not pulled in a systematic manner. Headings are driven too far before retreat mining begins, and too many rooms have been turned off at one time. Pillars are squeezed and crushed and cannot be recovered.

The bed is extremely irregular in thickness in some localities, and much coal is unavoidably lost because it cannot be recovered at present prices. However, some of this coal could be recovered if miners did not stop driving rooms when the coal decreases in thickness.

In areas where the Lower Freeport, which lies from 20 to 40 feet below, has been removed, the Upper Freeport is fractured and faulted beyond all hope of future recovery. The intervening rock is usually soft shale which fractures easily and slumps immediately after pillars are drawn in the Lower Freeport. If these pillars are not drawn large blocks of the Upper Freeport are fractured and the bottom heaved.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	7	5
In room, entry, and panel pillars	5	0
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	10	5
	26	10

Pittsburgh Coal.

Distribution and character. The easternmost remnant of the Pittsburgh bed occurs in the hills in the Berlin-Salisbury basin at Pinehill and south of Meyersdale, also a few hundred acres in the hilltops north of Wellersburg east of Allegheny Mountain. This bed has been mined since the early eighties, and is now approaching exhaustion. Production is limited to pillar pulling and mining of inferior crop coal.

The Pittsburgh bed has been almost entirely exhausted in Elk Lick township. The bed averages about 7 feet thick. At Salisbury the coal is in five benches, 5, 12, 30, 36, and 33 inches thick, separated by several 1/8 to 2 inch bone partings. The Pittsburgh bed ranges from 5 feet 6 inches to 6 feet 6 inches thick on Coal Run. It always has two or more thin bone partings. Production is limited to one stripping operation and a few mines which are pulling pillars and mining crop coal.

The Pittsburgh bed thins northward from Elk Lick township and the partings increase in thickness. South of Casselman River the production from the Pittsburgh bed is limited to the pulling of pillars in the old mines. On the hills north of Meyersdale, where the bed is extremely thin and poor in quality, it is mined by drift. The bed ranges from 2 feet 8 inches to 4 feet thick, and contains two or more bone partings ranging from 3 to 10 inches thick. Locally the bed contains numerous sulphur balls. One mile southwest of Miller school the bed is 5 feet 10 inches thick including a bottom bench of 30 inches of dirty coal which is not mined for

shipment, and also a 6-inch bone parting 18 inches from the top. At Shaw Mines the Pittsburgh bed is divided into three benches. The top bench averages 5 feet 10 inches thick and has excellent quality. A 10-inch binder of shale (blackjack) separates this bench from a middle bench which averages 7 inches thick. A 6-inch shale parting separates the middle from the lower bench, which is 22 inches thick. Locally these two lower benches are of good quality and are "loaded", but they are left in most mines.

As a result of several years study by the Maryland and Pennsylvania Geological Surveys, the Pine Hill No. 2 bed has been correlated as the stratigraphic equivalent of the Pittsburgh bed, and the Pine Hill No. 1 bed as the Sewickley. This correlation has met with the approval of mining engineers in this district.

The Pittsburgh bed is mined by drift in the vicinity of Pinehill where it ranges from 2 feet 8 inches to 4 feet 6 inches thick. The bed is never entirely free from impurities. A lower bench, ranging from 8 inches to 2 feet 10 inches thick, is usually full of "sulphur" streaks. The upper part of the bed commonly is parted by two or more shale binders ranging from $\frac{1}{4}$ to 12 inches thick. In general the bed is very regular. Locally sandstone faults partly cut out the bed. This coal is used for steaming purposes. It is picked by the miners and on the car before shipment.

Coal losses and mining methods. All the mines in the Pittsburgh are drift. Most of them are old, and many of them employ no method of mining. The average net width of entries is 12 feet; chain pillars, 20 feet. Rooms are driven on 35-foot centers, 10 feet of which is in pillar. Barrier pillars are 10 feet wide.

The average recovery in old Pittsburgh mines was approximately 55 per cent; in the few new mines it is 80 per cent.

The greatest avoidable loss was in room, entry, and panel pillars. Room pillars were only 10 feet wide, and were squeezed before they could be recovered. Entirely too much coal was taken out on advance, and retreat mining was rare.

The roof is draw slate and shale, and locally causes much trouble. A few inches of good coal is left to hold up the roof. This coal is not recovered. The bottom was not cleaned up properly before rooms were abandoned and much loose coal was covered by the break. Much coal was lost in handling and preparation principally because good coal was discarded with impurities on the gob. Headings and rooms were not cleaned up before mines were abandoned.

Coal losses in Pittsburgh bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	15	10
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	2	1
	26	14

Redstone Coal.

Distribution and character. The Redstone has been an important producer in the Berlin-Salisbury basin in the last few years although it does not have the thickness or the good quality of the Pittsburgh. It is extensively mined on properties where the Pittsburgh bed has been exhausted. Its average thickness is about 4 feet 2 inches exclusive of 4 feet to 4 feet 6 inches of dirty bony coal which is not mined but taken down in the headings and rooms for height. The mineable portion is generally divided into two or more benches by shale partings. Locally other small binders are present in addition to a small band of pyrite near the bottom.

At Salisbury the bed is 5 feet 2 inches thick not including two ½-inch shale binders. At Boynton it is 3 feet 6 inches thick not including two binders totaling 6 inches. At Coal Run the bed thickens to 4 feet 11 inches and the two binders are thin. In the vicinity of Meyersdale the bed carries a 1-inch binder of pyrite in addition to three shale binders totaling about 2½ inches thick. The bed is rather high in sulphur and ash.

Coal losses and mining methods. The mining system is entirely room and pillar. All mines are drift. The average net width of entries is 12 feet; chain pillars, 30 feet; rooms, 20 feet; room pillars, 15 feet; and barrier pillars, 50 feet.

The greatest avoidable loss in this bed is in leaving coal on top and bottom. Two inches of coal is left on the roof to hold it up, and an average of 3 inches of merchantable coal is left on the bottom by machine men after cutting. A rider coal above the Redstone, ranging from 6 inches to 2 feet 8 inches thick, is entirely lost because of its extreme irregularity. This rider coal is of inferior quality but could be made merchantable by using picking tables and washeries. This loss, of course, is not avoidable, considering the economic factors involved.

Much coal is lost in room, entry, and panel pillars due principally to undermining in the Pittsburgh bed which underlies the Redstone about 20 feet. The Redstone has been broken and fractured, and large blocks of coal have heaved and crumbled so much that they cannot be recovered. These heaves not only cause the loss of large areas of coal but prevent pillar pulling and cause much coal to be left on the bottom.

The bed is thin and dirty in some areas and cannot be commercially mined at present prices. These areas are driven around and are abandoned.

Coal losses in Redstone bed.

	Total	Avoidable
On roof and bottom	15	10
In room, entry, and panel pillars	15	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	3	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	5	2
	40	17

CONCLUSION.

Coal mining in this district is confined entirely to the thickest and the best quality coals. Very few mines are extracting coal from beds lying at a small vertical distance above or below a thick bed. An exception to this condition is in mining the Redstone bed in which fully 25 per cent of the loss is directly attributable to mining of the Pittsburgh bed beneath it.

At a few localities the Upper Freeport has been cracked and faulted by mining the Lower Freeport beneath it. At most places the intervening strata are strong enough to minimize this loss. Probably only 5 per cent of the loss in the Upper Freeport is due to undermining.

Rider coals, ranging from a few inches to 3 feet thick, are extremely variable in thickness and quality, are subject to sandstone and shale faults, and are entirely lacking in large areas. No attention is given these coals, and as they have never been prospected a reasonable estimate of the percentage recoverable is impossible. However, the coal is lost entirely without exception unless mined with the underlying bed.

This district is non-union and played an important part in the bituminous coal production in Pennsylvania during the recent strike. Men are generally paid an excess both for yardage and rock removal, and where mining is difficult. There is no district ruling prohibiting miners from working coal of certain height, or from removing pillars, etc. The loss of coal due to labor refusing to perform certain duties is very small and is not considered in this report.

The mines in the southern part of the district are practically all small, and labor is drawn chiefly from nearby towns. In northern Somerset County, where the mines are larger, companies have built mining towns and established modern conveniences for their workers. Living conditions are, in general, excellent in this district. Houses are kept in good repair, and the rents are very low.

Eight mines in this district were inspected, and maps of twenty others were studied in the office. These mines represented the mining conditions in every locality in the district.

Summary of coal losses in Somerset district.

	Total	Avoidable
On roof and bottom	7	3
In room, entry, and panel pillars	8	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	5	2
	24	10

CHAPTER XIV

CLEARFIELD DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Clearfield District lies in the west central part of Pennsylvania, and on the eastern edge of the main bituminous coal field. It includes all of Cameron, Clinton, and Centre counties; all of Clearfield County but Burnside, Bell, Brady, Sandy, Huston, Union, and the northern fifth of Lawrence townships; also Susquehanna, Barr, West Carroll, East Carroll, Elder, Chest, White, Clearfield, Dean, and Reade townships of Cambria County.

GEOLOGY.

Practically all of Clearfield County is underlain by the Allegheny group, which is the only commercial coal-bearing group of the district. This group has been eroded in Centre and Clinton counties with the exception of small local synclinal basins.

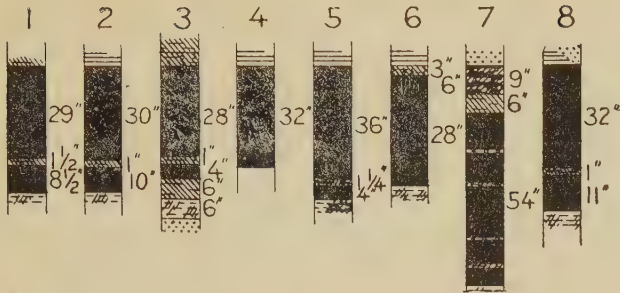
Approximately fifteen coal beds outcrop in the district six of which are being mined at present, the others being thin and unimportant. In order of present importance as shipping coals they are: the Lower Kittanning, Lower Freeport, Upper Freeport, Upper Kittanning, Middle Kittanning, and Brookville.

The Pottsville series outcrops extensively in the district, but the coals are thin and unimportant.

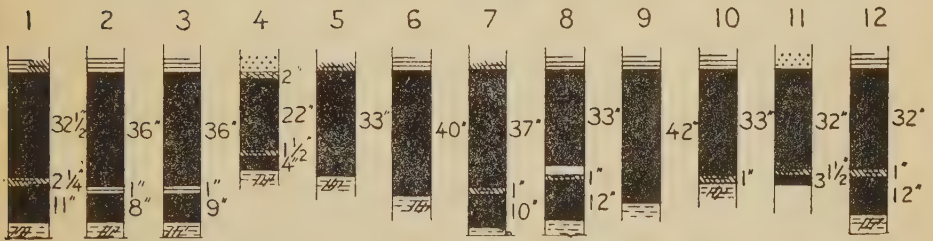
Generalized section of coal beds in Clearfield District.

Name of Bed		Internal	Average thickness of coal beds
Allegheny group 325'	Upper Freeport ("E")	45	3' 2"
	Lower Freeport (Moshannon "E")	50	3' 9"
	Upper Kittanning ("C")	60	3' 0"
	Middle Kittanning ("C")	50	2' 5"
	Lower Kittanning ("B")	90	3' 9"
	Brookville ("A")		3' 7"

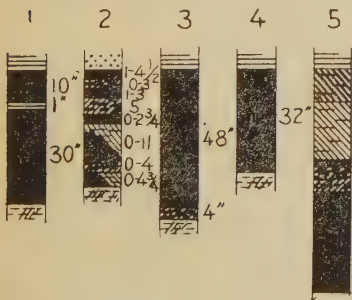
Upper Freeport



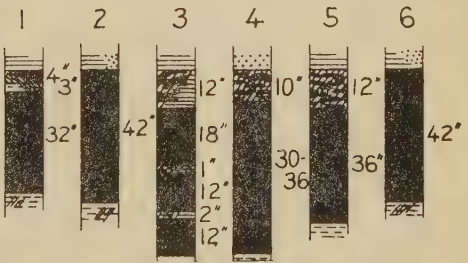
Lower Freeport



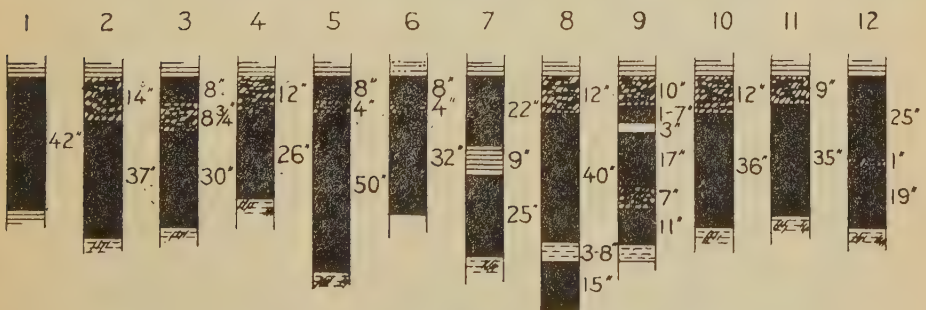
Upper Kittanning



Brookville



Lower Kittanning



Scale 1"=5'

Fig. 27 Sections of coal beds in operating mines in the Clearfield District, Pa.

GENERAL DISCUSSION BY BEDS.

Brookville ("A") Coal.

Distribution and character. The Brookville coal is fifth in size of reserve within the district, and ranks sixth in production with over 140,000 tons annually. This bed is extremely variable in thickness, and is entirely absent in large areas. It ranges from a few inches to 6 feet thick, and averages 4 feet. It is mined for shipping coal in Rush township, Centre County. Between Sandy Ridge and Osceola the mineable coal is 3 feet 6 inches to 5 feet thick, thinning where roof rolls are present. The bed carries a top bony bench 12 inches thick.

The Brookville coal is opened at many places in Rush township near Philipsburg, and ranges from 2 to 4 feet thick. It is generally rather dirty and high in sulphur, and invariably has a bony bench at the top 3 to 12 inches thick. Roof rolls make mining uncertain. Opposite Munsons and Winburne the bed averages 3 feet thick, not including a 6-inch bony bench at the top. The coal has fair quality, but is rather high in sulphur.

The Brookville coal is mined on Cherry Run, Snow Shoe township. Here it is 3 feet 6 inches to 4 feet 2 inches thick, not including an 8-inch bony bench at the top. The coal is rather high in sulphur, and both roof and bottom are very rolly. At Kato the bed is 4 feet thick, not including the top bony bench, and is very rolly.

On Little Clearfield Creek the Brookville is 3 feet to 3 feet 6 inches thick. The main bench is characteristically underlain by 12 inches of coal separated from the main bed by 4 or 5 feet of clay. In descending Little Clearfield Creek the interval between the two beds appears to decrease until south of Clearfield Bridge the coal is only 22 inches apart, the upper coal being a solid bench 2 feet thick, and the lower is 3 feet thick separated into three benches by shale partings. Beneath this lower bench is 10 to 16 inches of coal. In the vicinity of Blue Ball the coal, which is presumed to be the Brookville, averages about 3 feet 4 inches thick with 1½ inches of bone 15 inches from the top. Locally this bed is 5 feet thick in the vicinity of Blue Ball, but is extremely variable in thickness.

The Brookville coal has been opened by farmers in eastern Snow Shoe and Burnside townships, but it is dirty, and high in sulphur. It averages 3 feet thick.

The Brookville is extremely irregular in thickness in Clearfield County, ranging from a few inches to 4 feet thick. It is mined at a few points for local fuel.

The roof is soft bony coal and shale; the bottom is fire clay. The cover ranges from crop to 525 feet.

Coal losses and mining methods. All the mines in this bed are drift. The entries are 15 to 20 feet wide; chain pillars from 30 to

50 feet wide. Rooms are driven principally on 50 to 60 foot centers with pillars ranging from 20 to 40 feet thick, according to the thickness of overburden. The mines are very small, and little attention is paid to properly laying them out. The rooms are not driven on sights and the pillars are gouged out and made very thin. Under heavy cover large areas are lost by squeezes and creeps. The chain and barrier pillars are left in the mines when they are abandoned. The coal is soft and fragile and will not support much overburden. The rooms are driven entirely too wide in most mines. This not only crushes the pillars but necessitates heavier timbering. A large amount of coal is also lost in discarding areas that are slightly inferior in quality. Coal from these areas could very easily be mined and shipped separately. The loss in handling and preparation is very low considering the type of the mines and the methods employed.

Coal losses in Brookville bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	20	15
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	6	4
	36	23

Lower Kittanning ("B") Coal.

Distribution and character. The Lower Kittanning coal is the greatest reserve, and the largest producer within the district, yielding approximately 5,000,000 tons annually. It lies about 90 feet above the Brookville. It is important in Centre County, and near Retort averages 4 feet 7 inches thick, including 6 inches of bone coal about 6 inches from the top. At Osceola, it is 4 feet 6 inches to 5 feet thick, not including a bony bench at the top, 12 inches thick; at Boynton it ranges from 4 feet to 4 feet 8 inches thick, not including a 12-inch bony bench at the top. The Lower Kittanning is mined extensively at South Philipsburg, where it ranges from 4 feet to 5 feet 6 inches thick. Here it carries numerous bony bands, and part of the coal is canneloid, high in ash. On One Mile Run the coal averages 4 feet 2 inches thick, and generally has 6 to 9 inches of bone coal 8 inches from the top. A 1-inch pyrite band is invariably present 7 inches from the bottom. On North Run the coal averages 3 feet 6 inches thick, not including 12 to 15 inches of bone coal at the top. The roof is roly, and in places cuts out the bony coal. Opposite Munson the coal is 3 feet 6 inches thick. It has a characteristic bony bench at the top, and local bony partings in the main bench. At Tunnel Mines the bed averages 3 feet 6 inches thick, including 6 inches of bony coal at the top, and a local bone parting 1

inch thick near the middle. The Lower Kittanning is opened near Gorton for house fuel; it is 3 feet thick, but very impure.

The Lower Kittanning coal is mined extensively in the Snow Shoe-Moshannon area where it ranges from 3 to 5 feet thick. Its quality is variable. On Cherry Run it averages 3 feet 6 inches thick, and has 4 inches of bony coal at the top; at Moshannon 3 feet thick, including 9 inches of bony coal at the top; at Clarence (Snow Shoe) 4 feet 8 inches thick, including a 15-inch bench with many thin bone and pyrite partings, a 6-inch parting of clay and bone, 10 inches of good coal, a 4-inch bony parting, 17 inches of good coal, and a bony top 4 inches thick.

On Susquehanna River and Beech Creek the Lower Kittanning is thin, averaging less than 2 feet 6 inches thick, is dirty and present in isolated areas in the hills.

The Lower Kittanning coal ranges from 20 to 24 per cent volatile matter, 59 to 67 per cent fixed carbon, 6 to 16 per cent ash, 0.6 to 3 per cent sulphur. It is a soft friable coal with stick and block structure, and mines out in fair sized lumps.

The Lower Kittanning is typically a triple bed in Clearfield County, consisting of a lower bench of coal, a parting of fire clay, another bench of coal, a parting of fire clay, and an upper bench of coal. Frequently this upper bench is divided by a clay parting. The middle bench is commonly thicker than either of the other two. The bottom bench is often extremely high in sulphur, and is frequently left down. The top bench is sometimes only a few inches thick.

In the Moshannon basin the Lower Kittanning ranges from 2 feet 6 inches to 6 feet thick. It is split by many partings, and is higher in ash and sulphur than the Moshannon bed. The Lower Kittanning often occurs in three benches, two of which are being worked between Osceola and Powelton on White Side Creek. The parting between the two benches is usually bone, but locally it is clay or sandstone, having a thickness from a few inches to 4 feet. The middle bench is usually 3 feet or more thick, and below it is a parting often several feet thick of hard gnarly clay, below which is a bottom bench of clean coal usually 18 inches thick.

The Lower Kittanning is below drainage in the Muddy Run district but is probably workable in several areas. In the Madera district the Lower Kittanning is now coming into importance, averaging 3 feet thick including impurities.

In the Grampian district the Lower Kittanning coal averages over 2 feet thick and is usually clean.

The Lower Kittanning is also thin but of good quality in the Little Clearfield district. In the Clearfield Creek district the Lower Kittanning is being extensively mined at Coalport where it ranges from 5 to 6 feet thick. It is usually clean where 4 feet thick, but the

maximum thickness of 6 feet usually includes two shale and clay partings ranging from 6 to 14 inches thick.

The Lower Kittanning coal is now being worked extensively in Clearfield County, particularly since the Lower Freeport (Moshannon) is practically exhausted. It is never entirely clean, and ranges from 2 to 6 feet thick, averaging about 4 feet, including partings and binders having an average total of 4 inches.

The Lower Kittanning coal is very regular throughout the Barnesboro-Patton area, averaging 3 to 4 feet thick with one or two benches below, which locally can be worked with the main bench. The principal outcrops are in the valley of Clearfield Creek south of Coalport, in the valley of Chest Creek between Patton and Altburn, and on the headwaters of West Branch of the Susquehanna. In the vicinity of Delaney the bed is split into two benches by 12 inches of bone and shale; the top bench is 2 feet 6 inches thick, and the lower one 12 inches thick. At Bakerton the bed is 6 feet 10 inches thick, and is parted by shale into three benches. The top or main bench of good clean coal is 3 feet 10 inches thick. A 6-inch middle bench is separated from the top bench by 6 inches of shale. The lower bench is 14 inches thick, with 4 inches of shale between it and the middle bench. In the Clearfield Creek region the bed is divided by a bony parting into a top bench 17 inches thick and a lower one 2 feet 6 inches thick. The lower bench also carries a small bony parting 13 inches from the bottom. At St. Benedict the coal is 2 feet 8 inches thick with 18 inches of bony coal on top. This bed is regarded as one of the most valuable coals in the northern part of the county. A large area of the coal lies at considerable depth, and is practically untouched, since coals more easily reached for mining have had the preference. Its reputation as a superior steam coal indicates a large future production. It has a slightly higher sulphur content than the Lower Freeport coal of the same region, but it has less ash. The Lower Kittanning coal is not used alone for making coke, but when mixed with the Lower Freeport it gives a calculated coke value of 77 per cent.

The Lower Kittanning coal outcrops in the valley of Clearfield Creek and its tributaries and on the western slope of the Allegheny Front. It has been opened and developed at many places from Daugherty to the north line of the county. The bed varies from 12 inches to 4 feet thick and is divided into an upper and lower bench by a characteristic binder. Where the lower bench is unusually thick, the entire bed is mined and the parting of 2 to 5 inches of bone is picked out before shipment. Where the lower bench is thin, the upper bench forms the main part of the bed. The binder is then used as the bottom and the lower bench is not mined. The coal is fairly clean and the sulphur content is low; the ash is medium. The coal is used successfully for steam purposes. The bed is subject

to local rolls both on roof and bottom, and to pinches and swamps which cause great variation in thickness.

The cover ranges from crop to 600 feet. The roof is shale, sandstone, and bone varying locally; the bottom is medium hard clay.

Coal losses and mining methods. The mines in this bed are very numerous, and are operated by small companies. The mining system is entirely room and pillar. The net width of entries is generally 12 to 18 feet. The rooms range from 20 to 24 feet wide. In the majority of mines the rooms are only 20 feet wide.

Room pillars range from 16 to 24 feet wide. These pillars are often gouged in to 5 feet. The operators in this coal follow the lines of least resistance, picking the most easily accessible coal of best quality, and ignoring coal which will have future value. The future loss in this bed is difficult to estimate because many abandoned areas will finally be lost. The coal is a little below the usual average thickness of the bed, but is possibly a little better quality.

Absolute lack of plan in the mines allows miners to gouge rooms and drive them in a haphazard manner inviting squeezes and creeps. Not only is much coal lost, but enormous sums are used yearly in unnecessary timbering. Machine men also waste a large amount of coal by stepping-up over rolls on the bottom. The miners do not remove this coal. When the lower bench of this bed, which ranges from 4 to 22 inches thick, is slightly inferior in quality, it is left in place and will never be recovered. The loss in handling and preparation is large because miners discard good coal which stick to binders. The hauls in some of the mines are rather steep and the coal which sifts through loose end-gates on the cars, is mixed with motor sand and cannot be recovered.

Coal losses in Lower Kittanning bed.

	Total	Avoidable
On roof and bottom	6	4
In room, entry, and panel pillars	18	13
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	8	3
	38	22

Middle Kittanning ("C") Coal.

Distribution and character. The Middle Kittanning coal, lying about 50 feet above the Lower Kittanning, is sixth in size of reserve within the district, and ranks fifth in production with about 150,000 tons annually.

The physical and chemical character of this coal is known only in a few districts, and its commercial importance is doubtful until adjacent beds have been entirely exhausted. Although it is locally 4 feet thick, it is usually full of thin bone and pyrite partings which make the coal extremely impure. It is mined at only a few places

for commercial coal. The roof is hard shale; the bottom, soft fire clay. The cover ranges from crop to 275 feet.

Coal losses and mining methods. The mining system is entirely room and pillar. The entries are generally 20 feet wide; the chain pillars 30 feet wide. The rooms are driven on 50 foot centers, 23 feet of which is in pillar.

The greatest loss is in thin and dirty areas which cannot possibly be mined and shipped at present prices. These dirty areas are driven through or around, and will probably never be recovered. They are soon cut off from the main part of the mine by roof falls and by flooding, which prevents their profitable recovery. The mines in this bed are comparatively new and the pillar pulling methods are somewhat better than that employed in the Lower Kittanning. The room pillars are extracted very well, but the entry and chain pillars are not removed. The usual large amount of coal is wasted in handling and preparation when mixed with many fine bone and sulphur partings.

Undermining in the Lower Kittanning will cause some loss in this bed. This loss cannot be estimated because the Middle Kittanning has been mined in but a few places; since the pillars have not been pulled with any system in the Lower Kittanning the assumption is that the floor of the Middle Kittanning bed will be heaved and the coal crushed.

Coal losses in Middle Kittanning bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	15	5
	33	14

Upper Kittanning ("C") Coal.

Distribution and character. The Upper Kittanning coal, lying about 70 feet above the Middle Kittanning, is fourth in size of reserve within the district, and ranks fourth in production with over 200,000 tons annually. Little is known of the thickness and quality of this bed in large areas. It is an important coal in Centre County, and in the vicinity of Osceola and Philipsburg it ranges from 2 feet to 3 feet 6 inches thick. The coal is hard, and mines out in blocks. It carries no bone or shale partings, but sulphur streaks are numerous. The roof is generally roly.

The Upper Kittanning coal has been important in the Snow Shoe-Moshannon area, but is now practically exhausted. Its average shows a tripple bed, an upper bench 2 feet 4 inches to 2 feet 7 inches thick; a middle bench 14 to 18 inches; and a lower bench from 5 to

12 inches thick. The partings are generally less than 2 inches thick. It is a bright, hard coal, having good quality. The roof is very rolly.

The Upper Kittanning is probably of workable thickness in parts of the Pennville district. In Girard township, and eastern Goshen it is in places 4 feet thick, and has attained a thickness of 3 feet 6 inches in Karthaus township. At Westover, in Chest township, the bed is thick and clean. This coal has come into importance as a commercial coal producer with the rapid exhaustion of the overlying Moshannon bed. The Upper Kittanning is 2 feet 10 inches thick at Morrisdale, including a large shale parting in the middle. This parting is characteristic in practically the entire district.

The Upper Kittanning coal outcrops on Chest Creek and Brubaker Run north of Patton and Hastings, and along the valley of West Branch of the Susquehanna River. It is mined by drift and slope, chiefly in the vicinity of Patton and Hastings. Many country banks have been opened to supply house fuel on Chest Creek and West Branch of the Susquehanna and their tributaries. The coal locally has a maximum thickness of 5 feet, but the lower part is so cut by shale and bone partings that it is not mined. The average thickness of good coal is 3 feet 7 inches. In some places knife blades of sulphur are abundant but are the only impurity. The coal is not tested in large areas and its commercial value is unknown. The Upper Kittanning coal probably will not have the excellent quality of the other beds now being mined in the district. After these beds have been exhausted, profitable operation of the Upper Kittanning may be expected if the coal is picked and washed, as it is a good steam coal. No coking tests have been made of it.

The Upper Kittanning is also important in the Mountain district. It has been developed extensively at Daugherty, Lloydsville, and Blandburg. The coal has no characteristic impurities, although locally the bed is split into two benches by a thick bone parting. In such places the coal beneath the parting is not mined. In many localities the coal is overlain with a few inches of draw slate which is taken down in the rooms and headings for height. The bed varies much in thickness and quality. Its average thickness does not exceed 2 feet 6 inches. The coal does not rank with the Lower Kittanning in quality because iron pyrite makes the sulphur content very high. The ash is medium. Tests have shown that it is a very good steam coal, but is inclined to make large clinkers.

The roof is hard sandstone and shale; the bottom is medium hard fire clay. The cover ranges from crop to 300 feet.

Coal losses and mining methods. The Upper Kittanning coal is mined entirely by drift. The system of mining is room and pillar. The average width of entries is 16 feet; chain pillars are 35 feet wide. The rooms are driven on 36 foot centers, 16 feet of which is pillar work. The greatest loss in this bed is due to delay in remov-

ing room, entry, and panel pillars. This loss is not due primarily to squeezes and creeps, but to neglect. The most easily accessible coal is mined in order to increase production at minimum costs. Headings are driven entirely too far before retreat plans are begun, and too many rooms are turned off of these headings. The pillars are gouged out, and when allowed to stand for any length of time are squeezed and lost.

A large amount of coal is also lost due to rolls, thin and dirty areas. These areas are driven around and left in place when the mine is abandoned. A large amount of coal is also lost in handling and preparation. Gob lines are usually carried along the headings and much good coal is discarded with waste. The coal is soft and fragile, sifts through loose end-gates on cars and is tramped into the soft clay bottom, and mixed with motor sand. When men pick the coal on the cars much coal which sticks to shale and bone partings is discarded.

Coal losses in Upper Kittanning bed.

	Total	Avoidable
On roof and bottom	4	3
In room, entry, and panel pillars	15	10
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	3
In rolly, thin or dirty areas	10	4
	35	20

Lower Freeport ("D") Coal.

Distribution and character. The Lower Freeport coal, lying about 50 feet above the Upper Kittanning, was for many years the greatest producer within the district, but now is second in size of reserve, and ranks second in production with a total of about 3,000,000 tons annually.

The Lower Freeport coal, so important in Clearfield County, has been eroded in Centre County, with the exception of a few isolated areas along Moshannon Creek in the Osceola-Philipsburg district, and a few hilltops in the Snow Shoe-Moshannon district. Along Moshannon Creek it ranges from 2 to 5 feet thick, and is locally dirty. It generally occurs in two benches, the bottom and main one being separated from an upper bench by 2 to 4 inches of bony coal. The upper bench, usually from 6 to 12 inches thick, is partly canneloid.

On Cherry Run, in the Snow Shoe-Moshannon district, the Lower Freeport is locally 6 feet thick. The coal has fair quality, and has but one thin parting 18 inches from the bottom. At Clarence it is 4 feet thick, including 1 inch of bone 6 inches above the bottom; and at Moshannon 3 feet 6 inches thick.

The Lower Freeport coal, known as the Moshannon bed in Clearfield County, has good quality, and is of workable thickness in

parts of twelve townships. It ranges from 4 to 5 feet thick, varying locally from 3 to 9 feet. In the northeastern part of the Houtzdale-Philipsburg basin the bed usually carries a parting of shale from 1 to 2 inches thick from 6 to 15 inches above the bottom. In the vicinity of Houtzdale and northeast toward the Mapleton Branch the bed is all clean coal without partings, but often carries a layer of bony coal on top from 4 to 8 inches thick.

The Lower Freeport supplied coal from the Moshannon basin for many years. It is now rapidly being exhausted. It ranges from 4 to 6 feet thick throughout the basin, and averages approximately 5 feet. Generally the coal was clean but often $\frac{1}{2}$ to 1 inch of cannel or rich bone coal was present 2 feet above the bottom, and locally there is a small bench of coal above or below the main bench.

In the Muddy Run area the Lower Freeport is spilt into two benches and are locally as much as 55 feet apart. Where mined, the lower bench averages about 2 feet 6 inches thick; the upper bench is usually less than 2 feet thick.

The Lower Freeport coal has been practically exhausted in the Madera area. It averages about 4 feet thick, ranging from 3 to 5 feet including a bone coal layer near the top, and one or more thin local partings.

The Lower Freeport coal is worked at Devling, Glen Richey, and Susquehanna Bridge. The coal ranges from 2 feet 6 inches to 3 feet 4 inches thick in the vicinity of Oshanter, including $\frac{1}{2}$ to 2 inches of shale 5 to 10 inches above the bottom. It usually has a bony layer on top.

In the Grampian area the Lower Freeport is persistently workable. It ranges from 3 to 5 feet thick. The usual thickness is 3 feet 6 inches. In most localities it has a clay or shale parting 1 to 2 inches thick 2 to 5 inches above the bottom.

In the Little Clearfield area the Lower Freeport is mined principally in the vicinity of Gazzam. It averages 2 feet 6 inches thick and locally is 4 feet thick. It has a characteristic parting $\frac{1}{2}$ inch to 3 inches thick 2 to 6 inches above the bottom.

The Lower Freeport coal is important in the Clearfield Creek district. It has a thickness of 4 to 5 feet in the vicinity of McCartney, and in some mines a small bench of coal 12 inches thick is present above the main bench. At Glen Hope and Irvona the Lower Freeport ranges from 2 to 6 inches to 3 feet thick. At Berwinstale it is being mined commercially where its thickness is 3 feet or more. In this vicinity it is usually clean though locally it has a characteristic parting 8 inches above the bottom.

The Lower Freeport bed is the largest producer in the Barnesboro-Patton area, and in many localities it is fast being exhausted. The most extensive development is along West Branch, on Chest Creek, and on Brubaker Run. It has been mined for many

years by drift in the vicinity of Barnesboro, Spangler, Elmora, Moss Creek, Carrolltown, St. Bonifacious, and Hastings. The coal is from 3 feet 1½ inches to 5 feet 1 inch thick, averaging nearly 4 feet. The thickest coal is in the center of the Barnesboro basin. The coal thins south and southwest and loses its importance. A shale binder 1 to 3 inches occurs 8 to 12 inches from the bottom. The bed is much cut by clay veins, varying from 1 to 20 inches thick; the clay veins are so numerous in places that mining is unprofitable.

Locally a bone coal comes in between the coal bed and the roof. A local fold makes a disturbed area along West Branch; the coal is crumpled and thin. The Lower Freeport coal carries a large amount of pyrite in the form of knife blades and nodules. These impurities appear to decrease westward, where the coal is used extensively for coking. The coal ranks very high in quality, and has a lower sulphur content than any other coal in the district; its ash is also below the average of the other coals.

The Lower Freeport is thin and unimportant in most of the Mountain area. Its average thickness is less than 2 feet and its maximum thickness as observed by the writer does not exceed 2 feet 8 inches. The upper part is much cut by bone and shale partings. Numerous roof rolls cause much variation in thickness. Many mushroom mines opened during war time are now abandoned. A large future production cannot be predicted from this bed. The roof is shale and sandstone of varying hardness, and the bottom, soft clay. The cover ranges from crop to 250 feet.

Coal losses and mining methods. The Lower Freeport coal is mined by drift, slope, and shaft. The system of mining is entirely room and pillar.

The average net width of main, cross, and panel entries is 12 feet. The average net pillar width between main and cross entries is 40 feet. The average net width of side pillars is 30 feet. The room necks are 20 feet long and 10 feet wide. The rooms are generally driven on 45-foot centers, 21 feet of which is pillar. The greatest loss of coal is in abandoned pillars. The rooms are driven entirely too wide and are gouged on the sides, making the pillars so thin that they cannot hold up the overburden. Creeps on the roof and squeezes crush these pillars and they are lost. In many places insufficient timbering causes costly roof falls in the haulageways. These haulageways are then abandoned because of excessive costs of removing these falls and the pillars are lost. Approximately 4 per cent of the bed is left on the bottom by machine men. With proper supervision this coal could be entirely removed. The loss in handling and preparation in this bed is slightly less than the average for the district, because rooms and headings are kept fairly clean. The coal is loaded and used principally for local boiler fuel. Locally a large amount of coal

is lost in thin areas. Although this coal has excellent quality it cannot be commercially mined at present prices. These areas are abandoned and will never be recovered.

Coal losses in Lower Freeport bed.

	Total	Avoidable
On roof and bottom	4	3
In room, entry, and panel pillars	14	9
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	3	2
In roly, thin or dirty areas	3	1
	26	15

Upper Freeport ("E") Coal.

Distribution and character. The Upper Freeport coal, lying about 45 feet above the Lower Freeport, is third in size of reserve within the district, and ranks third in production with approximately 600,000 tons annually.

The Upper Freeport bed caps about twenty of the highest knobs on the western flank of Allegheny Mountain, in Centre County, and now is practically worked out. It ranges from 2 feet 6 inches to 5 feet thick, locally carries 2 inches of bone near the middle, and is usually a good hard coal. It has been coked with much success in the Snow Shoe-Moshannon district. Both roof and bottom of the bed are roly.

The Upper Freeport averages less than 3 feet thick and has been mined only at a few places in the Houtzdale-Philipsburg basin. Its area is limited, and it has been ruined in large areas by mining the Lower Freeport beneath it.

The Upper Freeport coal is mined extensively in the Barnesboro-Patton area. It is considered a very valuable coal although it has more sulphur than the Lower Freeport; its ash content is above the average. The bed outcrops well up on the hills along West Branch and Chest Creek and their tributaries. Its most extensive development is in the vicinity of Barnesboro. The thickness of the bed is variable; the maximum is 5 feet; the average 3 feet 6 inches. It carries partings and binders of bone and slate, varying much in thickness, persistence, and number. An 8-inch binder of shale, clay, or bone is common near the bottom. A 4-inch bench of coal which is never worked is always present below this binder. This bed is free from roof and bottom rolls and clay veins which are present in the coals beneath it. The coal is excellent for steaming purposes, and does not clinker under the boiler as much as would be expected of a coal so high in sulphur. It has been coked with varying success at Hastings and Moss Creek.

A large number of openings in the Mountain area are in this bed. Many farm and custom coal drifts are opened midway on the hill-

sides and numerous large mines are operated in it. The bed is not as thick in this area as in other parts of the district but its analyses compare favorably with those of the same coal in the Barnesboro-Patton area. The sulphur is rather high, but the ash is fairly low. No coking tests have been made on it, but it is reputed to be a good steam coal. This bed is thickest from Figart north along the Bellwood Branch of the Pennsylvania Railroad and in the valley of Clearfield Creek, but probably does not exceed 3 feet 9 inches thick. The bed is divided into two benches by a characteristic 1 to 2 inch bone parting, lying 4 to 14 inches from the bottom. This parting is readily separated by picking, so that both branches are profitably mined. The upper bench averages 2 feet 4 inches thick; the lower bench is 4 to 18 inches thick. New operations are beginning on Clearfield Creek and a large future production is predicted. The coal is of good quality, clean, with the exception of one small parting, and easily accessible by drift on the hill slopes. Large acreages are unprospected and when the better known areas of Cambria County have been exhausted, Clearfield Creek will undoubtedly become one of the large mining centers of the district.

The cover ranges from crop to 200 feet. The roof is hard sandstone and shale; the bottom soft fire clay. There are very few mines in this district with the exception of the Barnesboro-Patton area. Its most extensive development is in the vicinity of Barnesboro.

Coal losses and mining methods. The Upper Freeport coal is mined practically entirely by drift. The system of mining is room and pillar. The average net width of main, cross, and panel entries is 12 feet. The average net pillar width between main and cross entries is 40 feet. The average net width of side pillars is 30 feet. The room necks are 20 feet long, and 10 feet wide. The rooms are generally driven on 45-foot centers, 21 feet of which is pillar.

The room pillars in this bed are pulled better than the average for the district. If the rooms were run on sights and the pillars allowed to retain their proposed thickness, fully 5 per cent of the waste could be prevented. The majority of mines lack proper supervision in planning and laying out workings. A large amount of coal is lost on the bottom due to machine men stepping-up over rolls. This coal could also be recovered if the miners would remove it in the rooms.

The coal is soft and friable, and sifts through the loose end-gates on the cars. This coal is supposed to be reloaded and shipped, but the greater part of it is discarded on the gob. Also much coal is discarded on the gob which sticks to shale and bone partings. A large quantity of coal has been lost and will be lost in this bed due to its undermining. The Lower Freeport coal was the first bed mined in this district, and little attention was paid to pulling pillars. In some areas pillars have been pulled and in others they were left. Irregular fracture lines have run through the intervening strata, causing the

bottom in the Upper Freeport to heave. The coal is cracked and crushed. The roof is also greatly distorted and the cost of timbering would be prohibitive to mining.

Coal losses in Upper Freeport bed.

	Total	Avoidable
On roof and bottom	8	3
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	2	0
	26	13

CONCLUSION.

The mines in this district are both union and non-union. The writer was unable to notice any direct relationship between certain attitudes of labor and the percentage of lost coal. The operators have very little trouble in moving their men from one room to another, and local agreements as to yardage prevent trouble from that cause.

The Clearfield district has been important for many years, and the famous Moshannon bed has been the standard of steam coals in the east since the early sixties. This bed is now practically exhausted and the other beds which are locally of equally good quality have maintained the reputation of the Clearfield coals. The thinnest beds worked in Pennsylvania are in this district, and mining conditions are much more difficult than in the Pittsburgh district.

The majority of the operating companies are small and draw their labor from local sources. In the smaller towns and camps the sanitary conditions are very bad, and the companies pay no attention to the welfare of their workers. The larger companies, however, have built numerous towns that have modern accommodations for their workmen. The foreign element is large.

The writer chose seventeen mines which he believed representative of the entire district and located at different points. An intimate study was made of these mines in the field and later the mine maps were studied in the office. Data and maps of thirty other mines were also studied. The areas on these maps were calculated by a planimeter, and the theoretical loss calculated.

Summary of coal losses in Clearfield District.

	Total	Avoidable
On roof and bottom	5	4
In room, entry, and panel pillars	15	10
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	8	4
	34	20

CHAPTER XV.

HUNTINGDON-BROAD TOP DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

The Huntingdon-Broad Top district lies in the south central part of the State, in Bedford, Fulton, and Huntingdon counties. It is east of Allegheny Mountain, and isolated from the main bituminous field. Coal was first mined in this field during the Revolutionary War by Tories who sought refuge there to avoid fighting against England. The first commercial shipments were in 1853. Production increased and reached its peak in 1918.

GEOLOGY.

The coal-bearing formations in this district lie in a broad basin which has been faulted into numerous smaller sub-basins. The entire district is surrounded by non-coal-bearing rocks, principally the Pottsville, Mauch Chunk, Pocono, and Chemung. A portion of the Conemaugh and the entire Allegheny groups are present in this district. The Allegheny group, which contains all of the merchantable coals, has a very irregular outcrop along and in this series of synclinal folds which run in a general northeast-southwest direction.

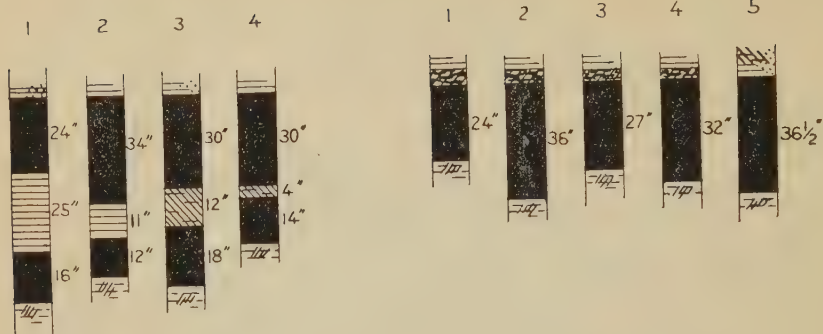
The group contains seven or more beds, three of which are of great commercial importance, and one or more have future commercial value.

Generalized section of coal beds in Huntingdon-Broad Top District.

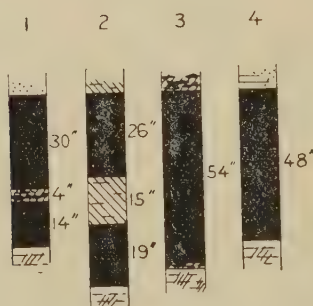
Group.	Name of bed	Average interval	Average thickness of coal beds
Conemaugh 530	{ Roger		4' 0"
	{ No merchantable coal		
	{ Kelly (Upper Freeport)	150	4' 0"
	{ Dudley (Lower Freeport)	61	5' 0"
Allegheny 375	{ Barnettstown (Upper Kittanning?)	50	1' 6"
	{ Twin Bed (Middle Kittanning?)	12	1' 0"
	{ Barnett (Lower Kittanning)	30	3' 0"
	{ Fulton (Clarion)	20	5' 0"
	{ Gordon (Brockville)	30	1' 0"
Pottsville	{ No merchantable coal		

Fulton

Barnett



Kelly



Scale 1"=5'

Fig.28 Sections of coal beds in operating mines in the Broad-Top District, Pa.

DETAILED DISCUSSION BY BEDS.

Pottsville Coals.

One or two coal horizons in the Pottsville series have been found in the Broad Top district. These horizons are generally marked by a few feet of bituminous shale and impure coal. These beds have no value. Farmers have made attempts to open them for local use without success.

Gordon (Brookville, "A") Coal.

The Gordon coal, at the base of the Allegheny group, is extremely irregular in thickness and quality in the district. It has been mined at one or two places by farmers for local use, but rarely averages over 12 inches thick. It will probably never have commercial value.

Fulton (Clarion, "A") Coal.

Distribution and character. The Fulton bed, lying 20 feet above the Gordon, varies from 3 to 5 feet thick, and usually contains at

least one parting of bituminous shale. The Fulton bed has been mined extensively on Shoup's Run, and in the East Broad Top basin. Its development is just beginning in the southern part of the field. The Fulton probably is persistent throughout the district. Locally the bed contains an appreciable amount of shale, which makes its future commercial value doubtful unless it is carefully cleaned. This condition is particularly true of areas on Six Mile, Sandy, and Kimber runs. On Broad Top anticline and in the Trough Creek or East Broad Top basin it is probably a very valuable bed.

The Fulton is a semibituminous coal. The average section is as follows: roof, shale; coal, 28 inches; shale, 47 inches; coal, 18 to 22 inches; shale, 2 inches; coal, 12 inches; bottom, clay. This bottom coal is not persistent in the entire field, and is often so thin that only the upper benches are mined. At the extreme eastern end of the field the whole bed pinches until it is not workable. The cover ranges from crop to 500 feet, averaging about 350 feet.

Coal losses and mining methods. The system of mining is entirely room and pillar. The mines are drifts and slopes. The net width of main entries is 20 feet. Chain pillars are 35 to 45 feet wide. Rooms are driven on 55-foot centers, 25 feet of which is pillar.

The greatest loss in this bed is in roly, thin and dirty areas. Approximately half of this loss is unavoidable because the bed thins so rapidly in certain localities that it can not possibly be mined commercially at present prices. Rolls on the roof and bottom often cut the coal out entirely, and these areas must be driven around. Clay veins are encountered, and partings thick enough to make impossible the commercial removal of the coal in the lower bench, which may be from 8 to 16 inches thick. Pillars have been pulled with fair success. The rooms are not run on line, and the miners gouge out the sides, making the pillars so thin that they squeeze under heavy cover, causing great losses. Retreat mining is often delayed until headings are driven too far. Creeps often destroy the room and chain pillars. Machine men leave 1 or 2 inches of coal on the bottom. The coal breaks clean from the roof and there is no loss of coal on the top.

Coal losses in Fulton bed.

	Total	Avoidable
On roof and bottom	4	4
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	15	8
	32	17

Barnett (Lower Kittanning, "B") Coal.

Distribution and character. The Barnett coal, lying about 30 feet above the Fulton, ranges from 3 to 4 feet thick. It is usually free

from large partings, and is a persistent bed. The section varies little from place to place. The bed usually has 4 to 6 inches of bone at the top, and frequently is divided into two or more benches by thin shale or bone partings. Where thinnest it is usually entirely free from partings and binders. The Barnett bed is mined extensively on Shoup's Run and in the East Broad Top basin. In recent years mines are being opened on Six Mile, Long, and Sandy runs. The Barnett bed will furnish the largest quantity of coal in future mining in the Broad Top district.

The cover ranges from crop to 500 feet, averaging 200 feet. The roof is hard sandstone; the bottom, medium hard shale, and locally, clay.

Coal losses and mining methods. The Barnett bed is mined by drift and slope. The entries are 20 feet wide. Chain pillars range from 35 to 40 feet wide. Rooms are driven on 50 to 55 foot centers. Room pillars are 20 feet wide.

The greatest loss in this bed is in room pillars. Rooms are not driven on sights and the pillars are too thin to withstand the weight of heavy cover. The miners gouge out the sides, often leaving 40 foot rooms with only 10 foot pillars on each side. These pillars are permitted to stand too long, squeezes and creeps crush them, and they are lost with the chain pillars. Much of this bed is less than 2 feet thick. It has been common practice to drive through these thin areas and not turn off rooms. Parts of many mines have been entirely abandoned, leaving large acreages of coal averaging 2 feet thick, and having excellent quality, which would have great future value.

The roof is generally very regular, but in places the bottom is roly and often cuts out the coal entirely. The loss in handling and preparation is exceedingly small. The room floors are always cleaned up before breaking the roof, and little coal is discarded on gobs and along haulways. Machine men often leave a maximum of 3 inches of coal on the bottom below the cut which, considering the thinness of the bed, adds an appreciable amount to the lost. By driving rooms on a 40 foot center with pillars 20 feet wide, practically all the pillars could be removed because the roof is free breaking and little timbering is necessary.

Coal losses in Barnett bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	15	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	2	0
In roly, thin or dirty areas	10	4
	34	12

Twin Bed.

The Twin bed occurring about 12 feet above the Barnett, is thin and without commercial importance. It is doubtful if any area will be found where this bed can be profitably mined. It is usually a solid, clean coal, but rarely 2 feet thick. Should any merchantable area of this coal be found and the Barnett mined out beneath it, the bed will be entirely ruined, unless sufficient time is given the intervening strata to settle after pillars have been pulled cleanly in the lower bed.

Barnettstown Bed.

The Barnettstown bed, lying 50 feet above the Twin bed, usually occurs in two or more benches separated by several feet of shale. The usual thickness of the upper bench is 18 inches, and the lower 16 inches. These beds will probably never be mined because of their extreme variability in thickness.

Dudley (Lower Freeport?, "D") Coal.

The Dudley coal bed lying about 61 feet above the Barnettstown, has been opened at a few localities for local use. There are no commercial mines in this bed because it is extremely dirty and impure. It averages about 5 feet thick, and consists of alternating bands of bone coal, shale, and coal.

Kelly (Upper Freeport, "E") Coal.

Distribution and character. The Kelly bed, lying 150 feet above the Dudley, and about 270 feet above the Barnett, has been mined extensively on Six Mile, Long, and Sandy runs. It ranges from 3 to 5 feet thick, averaging about 4 feet. A large amount of coal has been mined from this bed because of its easy accessibility, but no doubt much recoverable coal still remains.

The Kelly bed is invariably separated into two or more benches by a shale parting, at variable distances above the bottom. This parting often thickens to 3 feet or more, and the bed is double. The lower bench, which ranges from 2 to 12 inches thick, is not mined, although it has excellent quality. The cover ranges from crop to 600 feet thick, averaging 300 feet. The roof is black shale or shaly sandstone; the bottom invariably is clay.

Coal losses and mining methods. All of the mines in this bed are drift. Entries are 21 feet wide. Chain pillars range from 40 to 50 feet wide. Rooms are driven on 55-foot centers, 25 feet of which is in pillar. A large amount of coal is lost in room, entry, and panel pillars because the rooms are driven too wide and entry pillars are too small. No attention is given to increasing the room pillar width to compensate an increased cover thickness. The coal is fragile and squeezes with extreme ease. The rooms are gouged out on the sides and not carried on sights. Room pillars, which are supposed to be 20 and 25 feet thick, are in some places only

5 feet. Timbering is crushed by the load, and the pillars are lost. Large areas of this coal have been abandoned because of bad drainage conditions. Operators find that the financial loss is smaller by abandoning these areas. Where the bed is less than 2 feet thick it is not mined. These areas are abandoned and cut off from the main haulageways when retreat work is started.

A large quantity of coal is lost due to faulty conditions, especially in the nose of local anticlines or rolls. Whenever areas of coal containing one or more thin shale partings are driven into, they are abandoned, and cleaner areas sought. The companies intend to go back and recover these abandoned areas, but in a great many instances extensive roof falls on the haulageways will prevent. The only way to recover these areas is to drive in from the crop.

Coal losses in the Kelly bed.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	10	4
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	3	1
In roly, thin or dirty areas	10	3
	30	11

CONCLUSION.

The Huntingdon-Broad Top coal field is unionized. There has been practically no labor difficulties since this field was opened. The miners, as a rule, are very well satisfied as to pay and labor conditions. The labor force is mobile, and the miners do not refuse to perform labor of any sort providing that they are properly paid according to scale.

This coal district is thinly populated, the mining towns being situated chiefly along the railroad. Until the last few years labor was drawn principally from the local inhabitants. However, there has recently been an influx of foreign labor.

The sanitary conditions in the towns are, in general, very good. Some of the smaller settlements do not have any means of sewage disposal and the water supply is bad particularly during dry seasons. Most of the companies have provided schoolhouses and churches and are concerned with the welfare of their employees.

Summary of coal losses in Huntingdon-Broad Top District.

	Total	Avoidable
On roof and bottom	5	3
In room, entry, and panel pillars	12	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	2.5	0
In roly, thin or dirty areas	12.5	12
	34.0	20

CHAPTER XVI.

BLOSSBURG (TIOGA) DISTRICT.

LOCATION AND GEOGRAPHIC EXTENT.

Blossburg coal district is situated in southeastern Tioga County. Tioga County is about midway the length of the State on the New York boundary. Mining is confined to Morris, Duncan, Bloss, and Hamilton townships.

GEOLOGY.

A long, narrow basin extending from the southern edge of Tioga County near Lloyd to a point a few miles east of Fallbrook, Ward township, contains all the coals of the Allegheny group. The Pottsville series outcrops on the edge of the basin but is not coal-bearing.

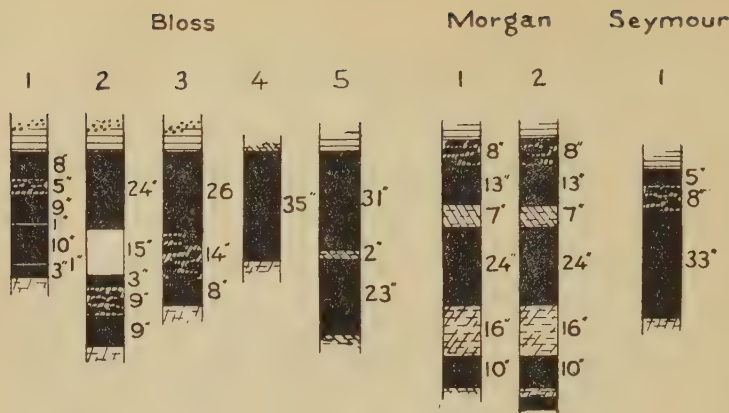
About nine beds outcrop in this canoe-shaped basin, four of which are mineable; the others are thin and unimportant. In former years the chief production has been from the Lower Kittanning or Bloss bed.

This district is one of the outlying, or detached coal fields of Pennsylvania. No detailed geological work has been done in this region and the correlations mentioned in this report are tentative.

The Bear Creek coal, lying from 20 to 40 feet below the Bloss, is probably either the Brookville or Clarion; the Bloss, the Lower Kittanning; the Morgan, the Lower Freeport; and the Seymour, the Upper Freeport.

Generalized section of coal beds in Blossburg District.

Name of bed	Average interval	Average thickness of coal beds
Seymour (Upper Freeport ?)	100	3' 0"
Morgan (Lower Freeport ?)	40	2' 8"
Bloss (Lower Kittanning ?)	30	2' 8"
Bear Creek (Brookville ?)		3' 0"



Scale 1"=5'

Fig.29 Sections of coal beds in operating mines in the Blossburg District, Pa.

DETAILED DISCUSSION BY BEDS.

Bear Creek Coal.

This bed, lying from 20 to 40 feet below the Bloss, is very irregular in thickness and quality. At Fallbrook it ranges from 12 inches to 2 feet 6 inches thick, averaging about 20 inches. At Morris Run the bed is much thicker but its quality is very poor. The bed contains many shale partings ranging from one-half inch to 2 inches thick. The bed thins again at Arnot but has better quality. It has never been prospected at Antrim. The coal from this bed has never been mined for shipping purposes but may have some local future value when the better and thicker beds have been exhausted.

Bloss (Lower Kittanning?) Coal.

Distribution and character. This is the most important bed in Tioga County. It has been a large producer for many years and is rapidly being exhausted. The chief markets are in New York State for domestic and steam purposes.

Average analysis of Bloss coal.

Volatile matter	20.0
Fixed carbon	69.0
Sulphur	1.0
Ash	10.0
	100.0

The Bloss ranges from 2 feet 6 inches to 4 feet thick, averaging 2 feet 8 inches; locally a bone parting 8 inches thick is present about 6 inches above the bottom. At Morris Run the coal averages 3 feet thick, is regular, and has excellent quality. Locally a 2-inch shale parting is present in the middle of the bed.

At Arnot the Bloss bed averages 2 feet 10 inches thick and is divided into irregular benches by two to four bone partings ranging from 1 to 8 inches thick. The coal ranges from 2 feet to 3 feet thick at Antrim and generally carries one or two bone partings ranging from 1 to 6 inches thick. The immediate roof is black shale below a massive sandstone. The bottom is invariably a medium hard clay. The cover ranges from crop to 300 feet. The distance to the next overlying bed is 40 feet, and to the underlying bed 30 feet.

Coal losses and mining methods. Mines in this bed are opened by drift. The system of mining is entirely room and pillar. The average net width of the entries is 10 feet. At Morris Run the entries are 20 feet wide, 12 feet of which is packwalled. The rooms are driven on approximately 70-foot centers, 30 feet of which is in pillars, making the rooms about 40 feet wide. Practically all of the advance and retreat work is pick.

The roof is fair in most of the mining districts. In places, however, it is necessary to leave 2 or 3 inches on top to hold up a loose shale which replaces the sandstone. Very little coal is left on the bottom by machine men at Morris Run. The floor is fairly free from rolls. At Arnot and Antrim an average of probably 2 inches of coal is left on the bottom. At Morris Run, boiler fuel is made from refuse picked from the gob piles and roadways. This coal is crushed and separated in a spiral separator.

Until 1915 fully 50 per cent of the entire bed was lost through failure to draw pillars. The coal is easily fractured, and is subject to heaves and squeezes. At the present time the rooms are being driven much narrower and more coal is left in first mining. The pillars are pulled fairly well. Retreat plans are delayed too long and too many rooms are turned off the headings. Much coal is lost in rib drawing. The floors of the rooms are not cleaned up when pillars are pulled. Insufficient timbering of butt headings often causes costly roof falls and the abandonment of large areas.

Coal losses in Bloss bed.

	Total	Avoidable
On roof and bottom	3	2
In room, entry, and panel pillars	10	5
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	2	0
In handling and preparation, underground and surface	4	1
In roly, thin or dirty areas	4	0
	23	8

Morgan (Lower Freeport?) Coal.

Distribution and character. This coal, lying about 40 feet above the Bloss, is generally of mineable thickness but is only locally of

good quality. In large areas the bed carries numerous shale, clay, and bone partings ranging from $\frac{1}{2}$ inch to 3 inches thick which completely ruin its commercial value. At Fallbrook it is 2 feet 1 inch thick including a 3-inch shale parting 10 inches above the bottom. At Morris Run, where it is now being mined, it ranges from 2 feet 6 inches to 3 feet 6 inches thick. Four to 10 inches of bone is characteristic at the top. Locally the bed is in one bench but generally a 4-inch shale parting is present from 16 to 26 inches above the bottom. The roof is invariably massive sandstone from which the coal breaks free. The bottom is also sandstone in many places, but the characteristic floor is clay and shale. The cover ranges from crop to 20 feet. The nearest workable beds are 60 feet above and 40 feet below. At Arnot and Antrim the bed ranges from 12 inches to 3 feet thick and is only locally clean enough to be mined profitably. It will undoubtedly have a great future value after the Bloss bed has been entirely exhausted.

Coal losses and mining methods. All mines in the Morgan coal are opened by drift. The prevailing system of mining is room and pillar. The net width of entries is 10 feet. At Morris Run the entries are 20 feet wide, 12 feet of which is packwalled. Rooms and pillars are the same size in the Morgan as in the Bloss, the centers averaging about 70 feet. Mining is done almost entirely by pick.

Mining in this bed has been started only in the last few years and little retreat work has been done. The pillars seem to have been pulled fairly clean. Much coal is lost in thin and dirty areas. In several localities much merchantable coal is left on the roof, the operators claiming that it ruins the quality of the shipments if it is loaded. The writer believes, however, that this coal has almost as good quality as the clean bench and should be mined and loaded separately.

This bed is now being mined at localities where the Bloss bed, 40 feet below it, has been mined out and abandoned. The under-mining seems to have had little effect upon the upper bed. In many places the coal has dropped free from the sandstone roof as much as 18 inches. The bottom is fractured and slightly heaved. The coal is crushed locally but not enough to prevent its entire recovery.

Coal losses in Morgan bed.

	Total	Avoidable
On roof and bottom	6	4
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	1
In roly, thin or dirty areas	4	2
	23	10

Seymour (Upper Freeport?) Coal.

Distribution and character. This bed, lying about 140 feet above the Bloss bed, will be important in the future. It is 2 feet 8 inches thick at Fallbrook, but contains one or more shale partings. At Morris Run it averages 3 feet thick including from 3 to 8 inches of bone coal on top. Locally one or more thin bone partings are present, but generally it is clean coal rather high in ash and sulphur. The roof invariably is shale, the bottom medium hard clay. The cover ranges from crop to 100 feet.

Coal losses and mining methods. All the mines in this bed are drift. The system of mining is room and pillar. Entries average 10 feet wide. At Morris Run the entries are 20 feet wide, 12 feet of which is packwalled. Rooms are driven on 70-foot centers, 30 feet of which is pillar work. At Morris Run double rooms are driven 42 feet wide, the single rooms being 21 feet wide. All mining is pick.

The bed is under thin cover and the roof is bad. Six inches of good coal is left on top in places to hold up the roof. Much coal is also lost in roly, thin and dirty areas, particularly in proximity with clay veins. The mines in this bed have only recently been opened and the writer was forced to base estimates of pillar loss upon few observations. The mining engineers appear to be very conscientious in believing that they will eventually recover a large percentage of their pillars.

Coal losses in Seymour bed.

	Total	Avoidable
On roof and bottom	15	5
In room, entry, and panel pillars	8	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	5	2
In handling and preparation, underground and surface	4	1
In roly, thin or dirty areas	5	2
	37	13

CONCLUSION.

The first mine in this district was opened at Morris Run in 1860, to supply local needs. Production gradually increased from that date and the peak was reached between 1880 and 1890. The bulk of future production will come from the Morgan and Seymour beds. The district is unionized but the operators have no difficulty in placing men or in having men perform certain duties that increase the percentage of recovery in mining.

The living conditions of the Blossburg field are very good, especially at Morris Run where the company owns ground and has provided its employees with amusements, churches, and school-houses.

The small population is grouped into three or four mining villages. Each village is well laid out, and adequate provision is made for water supply and sewerage disposal.

Five mines typical of the entire district as to coal waste and mining conditions were studied in the field. Later, several maps submitted by various mining companies, were studied in the office. The mined-out areas were measured with a planimeter and compared with the production, giving a check on the coal loss figures.

Summary of coal losses in Blossburg district.

	Total	Avoidable
On roof and bottom	6	2
In room, entry, and panel pillars	9	3
In oil and gas well pillars	0	0
In boundaries, under buildings, railroads, and streams	1	0
In handling and preparation, underground and surface	4	2
In roly, thin or dirty areas	4	2
	24	9

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